S. HRG. 105–407

WATER POLLUTION RISKS OF METHYL TERTIARY BUTYL ETHER (MTBE)

FIELD HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED FIFTH CONGRESS

FIRST SESSION

ON

THE PRESENCE OF METHYL TERTIARY BUTYL ETHER (MTBE) IN THE NATION'S WATER SUPPLY

DECEMBER 9, 1997—SACRAMENTO, CALIFORNIA

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DECEMBER 9, 1997—SACRAMENTO, CA

WATER POLLUTION RISKS OF METHYL TERTIARY BUTYL ETHER (MTBE)

TUESDAY, DECEMBER 9, 1997

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Sacramento, California.

The committee met, pursuant to notice, at 9 a.m. in room 4203, State Capitol Building, Sacramento, California, Hon. Barbara Boxer presiding.

Present: Senator Boxer.

OPENING STATEMENT OF HON. BARBARA BOXER, U.S. SENATOR FROM THE STATE OF CALIFORNIA

Senator BOXER. I call to order a field hearing of the Environment and Public Works Committee of the U.S. Senate. I want to welcome our first panel, whom I'll be introducing shortly.

I first want to thank my colleague, Senator John Chafee, who is chairman of the Environment and Public Works Committee of the Senate, for approving this field hearing and recognizing the importance of the issue before us today. He is very sorry that his schedule and the scheduling constraints of other committee members did not permit them to be here, but I will be reporting back to them in detail on the issues raised here today.

With this committee hearing we are initiating what I expect will be a very comprehensive Federal review of the risks and benefits associated with the use of the chemical methyl tertiary butyl ether, commonly referred to as MTBE.

MTBE is an oxygenate which is added to gasoline to make it burn more cleanly and efficiently. The blending of oxygenates in gasoline is required by the 1990 Clean Air Act and it is a key component in our nation's strategy to help meet Federal air quality standards for carbon monoxide and ozone because it results in cleaner tailpipe emissions.

The potential risks of MTBE came to my attention in February 1996, when I met with Mayor Pam O'Connor of the city of Santa Monica, in my office in Washington. High levels of MTBE contamination had been discovered in the city of Santa Monica, in its drinking water wells. The suspected source of the contamination was nearby underground gasoline storage tanks and fuel pipelines. Santa Monica has now lost over 70 percent of its local drinking water supply. The city needed help from the Environmental Protection Agency in tracking down the source of the contamination and coordinating the cleanup of the contaminated wells.

I immediately contacted EPA Administrator Carol Browner asking that she do the following things: One, work closely with Santa Monica to expedite site evaluation and cleanup; two, provide direction on the appropriate remediation and treatment technologies so that Santa Monica's problems can be corrected and their drinking water protected, and then we could apply those technologies as needed to protect the nation's water supply; and, three, consider establishing safe drinking water standards for MTBE.

The city of Santa Monica is on the first panel today to give us an account of what they're going through and where cleanup efforts stand.

The EPA has made significant progress on my call for research and the setting of health standards. In September 1997 EPA announced a new research plan to further our knowledge of remediation and treatment technologies, and the potential health effects of exposure to MTBE.

Yesterday, just yesterday, the EPA announced a revised drinking water health and consumer acceptability advisory for MTBE, which recommends a range of 20 to 40 parts per billion, down from the 1992 advisory range of 20 to 200 parts per billion. So EPA is saying now 20 to 40 parts per billion, not 20 to 200 parts per billion. Now, an advisory is a nonenforceable recommended change of concentration levels of MTBE in drinking water based on current health effects research and odor and taste thresholds.

In October 1997 EPA also announced it's considering setting a Federal standard for MTBE in drinking water—a standard as opposed to an advisory. A standard is an enforceable limit for a particular pollutant.

Clearly, progress is being made, but we still need answers to basic questions, many of which we will explore during this hearing, questions like: How pervasive is MTBE contamination of our nation's drinking water and groundwater today? If the major source of MTBE contamination is leaking underground gas storage tanks and fuel pipelines how many of these are located near sources of drinking water? Are there immediate safety measures we can take to prevent MTBE contamination at these sites? Will we be safe from significant levels of MTBE contamination if all tanks are replaced and closely monitored, or can MTBE corrode through new tanks, a very important question that will be raised today. Once MTBE gets into the soil and water why is it so slow to biodegrade into a harmless substance? How can we clean it up cost effectively, given how quickly it leaks through the soil into the groundwater?

In California MTBE has been found in about 8 percent of drinking water wells and groundwater tested so far, from Orange County at 38 parts per billion, to Los Angeles at 13 parts per billion, to Sacramento. It has been detected in over 13 lakes and reservoirs, including Donner Lake at 12 parts per billion, and Lake Tahoe, levels as high as 47 parts per billion. We have someone here from the South Lake Tahoe Public Utility District who will join us when we get to the question part.

The U.S. Geological Survey's MTBE test program has revealed the presence of MTBE in groundwater in Colorado, Connecticut, Georgia, Massachusetts, New Jersey, New Mexico, Nevada, New York, Pennsylvania, Texas, Virginia, Vermont, Washington and

Wisconsin. That's why my colleagues on the committee consider this very much a national issue.

Part of what we need to learn today is how serious the problem is. If the risks to our drinking water are as serious as many believe, then we will need to consider taking several possible actions, and let me lay out what some of those are:

One, asking the Administrator of EPA to use her emergency authority under the Clean Air Act to curb or stop the use of MTBE in order to protect the public health and welfare. I want to point out that that would take absolutely no legislation. It wouldn't have to reopen the Clean Air Act. She has the emergency powers to do that.

We could also amend Federal laws to require nationwide monitoring of MTBE in air and water.

Three, we can amend Federal laws, including the Clean Air Act, the Clean Water Act, and the Safe Drinking Water Act, to set controls on the amount of MTBE allowed in air and water.

Four, look at ways to offer Federal help to communities, such as Santa Monica, that are facing contamination prevention and cleanup issues.

During the last year California lawmakers have been intensely debating MTBE. This debate culminated in four bills being signed into law, authored by Senators Hayden and Mountjoy, and Assembly Members Kuehl and Cunneen. The bills appropriate funds for health effects research, require the State to develop drinking water standards for MTBE, and make a recommendation as to whether MTBE should be listed as a carcinogen under Prop 65, and authorize projects to map leaking underground storage tanks and pipeline locations, and study cost-effective alternatives to MTBE. The Cunneen bill prohibits the delivery of gasoline to any underground storage tank that does not meet the December 22, 1998, Federal and State upgrade or replace deadline.

I want to thank so very much these legislators who are here before us today, and others. I know that Senator Mike Thompson has his staff here. He wanted to be on the panel but just could not fit it in today to his schedule. But I want to thank all of you for your leadership, and I believe we need to consider the appropriateness of similar measures at the Federal level. So you are really helping me, senators.

Let me reassure you all here today that we are looking for answers to the challenges faced by California and other States due to MTBE use. It is estimated that California could be up to six million acre feet short of water each year by the year 2020 unless additional water management strategies are adopted. Clearly, the State of California simply cannot afford to lose any of its limited water resources to MTBE contamination.

Now, I'm going to be asking some very tough questions today of the EPA, to try to get to the bottom of this MTBE problem. Why aren't we testing inhalation health effects on animals of MTBE in gasoline? So far studies have only been done on exposure to pure MTBE. What about potential synergistic health effects? What do we know about how MTBE affects the central nervous system?

I will be quoting from a recent Presidential report which says that because of the very limited research that's been done on

MTBE the extent of MTBE occurrence in drinking water nationwide and the health effects of MTBE exposure are unknown. Doesn't this give us reason to act now to phaseout MTBE until we have answers to these critical questions?

I will be also asking EPA: Are the Federal requirements regarding the quality of underground storage tanks sufficient to protect against concerns about the corrosive nature of MTBE? We must keep our air clean and protect our drinking water as well. We have to do both. That is the challenge we face with MTBE, and with the knowledge we gain today I trust that we'll have a road map to begin to meet that challenge.

[An exchange of correspondence between Senator Boxer and EPA Administrator Browner follows:]

UNITED STATES SENATE,
OFFICE OF SENATOR BARBARA BOXER,
Washington, DC 20510, February 25, 1997.

THE HONORABLE CAROL H. BROWNER, *Administrator,*
Environmental Protection Agency
Washington. DC 20460, February 25, 1997

DEAR ADMINISTRATOR BROWNER: I am writing to you again about the drinking water contamination in the City of Santa Monica, California. The recent consent agreement between the California Regional Water Quality Board, Los Angeles Region and Mobil Oil Company presents additional factors that must be considered in addressing this issue.

As you know, MTBE has contaminated Santa Monica's drinking water supply. The City has already been forced to close two of its wells and must now deal with clean-up and abatement. The City of Santa Monica has come to me and raised the following questions:

1. Will U.S. EPA overfile the State Water Board's actions and take prompt enforcement and other appropriate actions?
2. Will U.S. EPA use its authority under the federal CERCLA law to pursue an administrative order or consent order so that Santa Monica's water is restored as soon as possible and that a proper precedent is set for the region and the rest of the nation'?
3. Will U.S. EPA provide direction on the appropriate remediation/treatment technologies so that Santa Monica's water problem is corrected and the nation's water supply is protected
4. Will U.S. EPA immediately order Mobil Oil Company to purchase replacement water from the Metropolitan Water District of Southern California to replace water lost as a result of the pollution to the Arcadia well?
5. When will you meet with Mayor Pam O'Connor?

The ultimate goal of city officials is the protection of public health and safety. They fear that the consent agreement may preclude the most efficient. cost-effective actions from occurring.

I ask you to explore the full extent of the Environmental Protection Agency's authority to assist the City. Further, I urge you to consider actions which would ensure a prompt and effective clean-up and abatement to ensure the protection of public health and safety.

In order to respond to these questions and any other concerns that the City may have. I urge you to meet with Pam O'Connor, Mayor of Santa Monica.

Again, thank you for your attention to this matter.

Sincerely,

BARBARA BOXER,
United States Senator.

UNITED STATES SENATE,
OFFICE OF SENATOR BARBARA BOXER,
Washington, DC 20510, April 3, 1997.

CAROL M. BROWNER, *Administrator,*
Environmental Protection Agency
Washington, DC 20460

DEAR ADMINISTRATOR BROWNER: I have corresponded with you in the past few months regarding methyl tert-butyl ether (MTBE) contamination in the drinking water for the City of Santa Monica. Recent reports indicate an increased frequency of MTBE detection in drinking water supplies throughout California and the nation.

MTBE is reported to have been found in at least 12 drinking water reservoirs throughout California. The chemical is thought to be entering reservoirs from boat exhaust and possibly from windborne emissions, and is leaching into wells from leaking underground tanks. Water districts throughout the country are just now becoming aware of the problem and beginning to monitor water supplies.

MTBE is classified as a probable human carcinogen. At high levels, the chemical is thought to cause serious health effects; at lower levels, water is not potable. This appears to be a potential major problem.

The air benefits of MTBE appear clear. But the potential hazard to drinking water is less well understood and raises disturbing concerns. Clearly, we must do more than simply monitor increasing levels of contamination. I have been informed by Regional Administrator Felicia Marcus that U.S. EPA is revising its draft health advisory, originally issued in 1992.

I would like to know what the EPA is doing to investigate this problem. How serious do you perceive the problem to be? What alternatives to MTBE are available that may provide clean air benefits without the water contamination problem? What is your timetable for further study and action?

Thank you for your attention to this important matter.

Sincerely,

BARBARA BOXER,
United States Senate.

U.S. ENVIRONMENTAL PROTECTION AGENCY,
OFFICE OF AIR AND RADIATION,
Washington, DC 20450, May 22, 1997.

HONORABLE BARBARA BOXER,
United States Senate,
Washington, DC 20510.

DEAR SENATOR BOXER: Thank you for your letter of April 3, 1997 regarding the gasoline additive methyl tertiary butyl either (MTBE). You stated that while the air quality benefits of MTBE-oxygenated gasoline are clear, you are concerned about the potential hazard of MTBE-contaminated drinking water. We take this issue seriously and want to address the issues you have raised.

As you noted there have been some detections of MTBE in water in various locations around the country, including California. With the exception of sites that are known to have been contaminated with petroleum products. the detected levels are usually below the lower limit of Environmental Protection Agency's (EPA) 1992 draft drinking water lifetime health advisory of 20 to 200 µg/L. EPA's Office of Water is currently preparing an Interim Health Advisory which is scheduled to be released in the summer or 1997. Health advisories are technical guidance documents to assist Federal, State, and local officials by providing information on health and aesthetic effects, and the concentrations of contaminants in drinking water at which adverse effects would not be anticipated. They are nonregulatory and not legally enforceable by EPA.

MTBE occurrences in water at concentrations above the levels contained in the draft health advisory seem to result primarily from point sources such as leaking underground storage tanks or pipelines. EPA's ongoing efforts under the leaking underground storage tank program are expected to reduce groundwater contamination from fuels whether they contain MTBE or not. Existing tanks are required to be upgraded, replaced, or closed by December 1998 to meet the spill, overfill, and corrosion protection requirements and in California are also required to be lined or double-walled. EPA anticipates that accidental UST releases will be significantly reduced once UST upgrades have been completed. The Agency's Office of Underground Storage Tanks is working with states to assist them in addressing MTBE when petroleum leaks are remediated. The regulation of gasoline pipelines, another potential source of leaks, is under the jurisdiction of the U.S. Department of Transportation (DOT). The Agency is currently contacting DOT on its pipeline leak prevention program to ensure it addresses our concerns.

You stated in the letter that MTBE is a probable human carcinogen. EPA has not classified MTBE as such. EPA has only classified MTBE as a "possible human carcinogen" in its 1993/94 assessment documents, which used information available at

that time including chronic inhalation studies developed pursuant to Toxic Substances Control Act (TSCA) during 1988–1999. EPA has actively pursued a program of research and assessment to ensure the classification reflects the state of the science. Since 1995, EPA has been participating with the White House Office of Science and Technology Policy (OSTP) in an interagency assessment effort that is addressing all available health data associated with MTBE and its use in oxygenated gasoline. As part of the interagency assessment, OSTP has been reviewing the available research with regard to MTBE's potential carcinogenicity via long-term ingestion in rodents, together with the results of long-term inhalation studies in rats and mice. OSTP's report will be completed this summer.

The Agency is also ensuring that further studies on oxygenated fuel exposure and health effects are conducted to fill gaps in existing data. The key question is how the risks and benefits associated with oxygenated gasoline compare to those for conventional gasoline. Studies that are needed to provide an adequate basis for quantitative assessments have been discussed at greater length in "Oxyfuels Information Needs" (EPA Report 600/R-96/069). Among the areas of needed information identified in that document are restore data on health effects of emissions related to mixtures of gasoline and MTBE (as opposed to MTBE alone) and more data on personal exposure levels to combustion and evaporative emissions from the use of these fuels. EPA is in the process or developing extensive testing requirements for MTBE, other oxygenates, and conventional gasoline to be conducted by industry under section 211 of the Clean Air Act (CAA). Section 211 includes a series of emissions-based information and testing requirements which fuel and additive manufacturers must satisfy to obtain or retain EPA registration for their products. Discussions about the scope of the testing requirements with industry include animal research as well as human exposure research. The Section 211 notice will be finalized soon and the research will be completed at varying intervals over the next five years.

The Agency has also recently formed a cross-media research group, led by the Office of Research and Development (ORD), which has been actively assessing and prioritizing research and monitoring needs for MTBE in water. The identified research will help provide the necessary information to better understand the health effects of MTBE in water, and to further our knowledge on remediation techniques. Information needed to provide the basis for monitoring strategies Null also be considered. EPA anticipates having the research prioritized this summer succeeded by appropriate actions.

You asked how serious EPA perceives the problem to be. Based upon the limited data available, EPA agrees with the National Academy of Sciences' conclusion in 1996 that drinking water does not appear to be a major MTBE exposure pathway for much of the population. However, the NAS and EPA recognize that there is a lack of monitoring data to accurately assess the exposure of humans to MTBE. EPA is thus committed to collecting data from states on MTBE occurrence in public water systems (PWS), and is currently exploring a mechanism for data reporting and storage. Another undertaking that EPA's Office of Water is pursuing is a project with the U.S. Geological Survey. It is a retrospective data analysis for MTBE and other volatile organic compounds (VOCs) in ground and drinking water in twelve New England and Mid-Atlantic states. The formal scope of work is still in development, but the plan is to focus primarily on ambient ground water in conjunction with PWS data available from state programs.

You also asked what alternatives to MTBE are available that may provide clean air benefits without the water contamination problem.. MTBE is the predominant oxygenate used today, primarily for economic reasons and blending characteristics. It is used in 84 percent of the reformulated gasoline (RFG). Ethanol is used in 14 percent of the RFG Other oxygenates, such as tertiary amyl methyl ether (TAME), and ethyl tertiary butyl ether (ETBE) are starting to be used by some refiners. These two combined are used in about 2 percent of total RFG. Although significantly less research has been performed on these alternative oxygenates in comparison to MTBE, testing under section 211 along with the research identified by the Agency workgroup will provide more information on their characteristics and health effects.

In reference to the contamination at Santa Monica drinking water wellfields, EPA's first priority is to ensure that public health and the environment are protected. As you know, we are undertaking a federal enforcement effort to address MTBE contamination at the Charnock wellfield, and monitoring the State's enforcement at the Arcadia wellfield.

Again, thank you for contacting the agency with your concerns and questions. I hope this information is useful. If you have any further questions, please contact us.

Sincerely yours,

MARY L. NICHOLS,
Assistant Administrator for Air and Radiation.

Our first panel of witnesses will focus on actions that have been taken in the State of California, some of which I glossed over. State Senator Hayden and State Senator Mountjoy have played a key role in this debate, and the city of Santa Monica is joining us. Mr. Perkins is here as well. I am very pleased to see you here.

Now, I just—I know everyone knows about the timer rules. I'm trying to keep it, if we can, only because of the fact that we have three panels. So after the red light goes on I'll give you another minute.

OK. It's not working. I always marvel at the fact we could put a person on the moon but we can never get these things to work.

Senator MOUNTJOY. We'll use our good judgment.

Senator BOXER. After 5 minutes we'll just give you a little nod and then try to conclude.

But I am so very pleased that you are here, and I want you to know your written testimony and any other documents you wish to submit will be submitted on your behalf for the record. The proceedings of this hearing and any other written testimony which is submitted by members of the public who didn't have the opportunity to testify today will also be part of the official committee record. If there's any more materials you come up with after this—the deadline is December 23—get us those materials and we'll make sure that you're in the Congressional record of this hearing.

Senator Hayden, welcome, and will you begin, and then we'll turn to Senator Mountjoy.

STATEMENT OF HON. TOM HAYDEN, A STATE SENATOR FROM THE STATE OF CALIFORNIA

Senator HAYDEN. Thank you very much, Senator Boxer. I appreciate your holding the hearing and I appreciate your concern about the entire question of water supply and quality in California.

Senator Mountjoy and I have offered legislation which has passed—Senate Bill 1189, which is mine, includes a $5 million cleanup fund for affected cities like Santa Monica, and it requires the establishment of standards for primary and secondary standards, that is, for health and for taste and odor, as well as a Prop 65 finding as to neurotoxicity in the next year. I'm simply going to submit that legislation to you and count on my friends from Santa Monica to amplify the plight that they are in, which was the origin of my involvement.

The purpose of this hearing, as I understand it, is to submit testimony on the health impacts of MTBE in our drinking water, and I think that the scientific evidence points toward MTBE as both a carcinogen and a neurotoxin. I am submitting two papers to you that are extensive, done at my request, as to its cancer-causing impact.

The one by Dr. Froines, who's the chairman of the UCLA Environmental—or, Health Sciences Department—concludes, after a

very cautious analysis I think, that MTBE is a B2 probable carcinogen, which means it needs more study, but on the basis of what is known it's a probable carcinogen. You look at the structure activity of its components, the genotoxicity, the case studies, the epidemiology and the animal studies.

He cites the Health Effects Institute, which is a very reliable body. The HEI conclusion—they did a report on oxygenates in gasoline, and in the cautious words of science their conclusion I think is noteworthy, and I'm quoting it: "In assessing the overall significance of the cumulative data produced by the studies investigating MTBE in rodents the most disconcerting aspect of the findings is that the two chemicals, MTBE and TBA, produce tumors at five different organ sites in two strains of two species. Considering the mechanisms of action of these and other nonmutagenic rodent carcinogens to be poorly understood, it would seem imprudent to dismiss these results as irrelevant to the human condition."

In other words, the findings of cancer in animal studies are relevant to humans.

As to neurotoxicity, the effect on the central nervous system, I'm submitting testimony by Dr. Jorge Mancillas, who was formerly the UCLA researcher who's now with my staff. He notes that as far back as nearly a decade ago, 1988, the Interagency Testing Committee gave MTBE an A designation, which means that it had an unreasonable risk of neurotoxicity for which there is substantial human exposure. Animal inhalation studies have shown the neurotoxic effects which have to do with the depression of the central nervous system's activity.

Dr. Mancillas also goes into some detail about the controversies between scientists that have flared up, and concludes that the original studies indicating the neurotoxic effects of MTBE have been misrepresented or ignored by public agencies, including the CAL-EPA.

I'll simply submit the testimony. It's quite extensive and detailed, and I think very reliable.

Senator BOXER. We will put it all on the record.

Senator HAYDEN. I appreciate that.

More research is going to happen. It's always helpful. But I think what should be condemned without reservation is the fact that without conclusive evidence that MTBE was safe, it was introduced in California and now our groundwater is at risk, and the public rightly should be concerned with having to play the experimental role of guinea pigs.

The original point of our legislation, in fact, was to place the burden of proof on the other side, on the State and industry, to show by a time certain a reasonable deadline that MTBE was safe for public exposure or else that it be phased out. That legislative intent was weakened during the legislative struggle of the past year, but the final passage of these bills seems to have contributed to an atmosphere that has caused a basic rethinking by industry of the prudence of continuing to rely on MTBE.

As you know, Chevron and Tosco have made business decisions to consider alternatives to MTBE even before waiting for further evidence or public outcry over its impact on groundwater. In the meantime, we have a lot of groundwater to clean up, not simply in

Santa Monica but across the State, and apparently across the country.

MTBE may not have a future at all. I believe it's a public health threat, but its future will depend on further study and decisions by the oil industry of the kind that we've seen in the past couple of weeks.

What I would like to comment on is how the situation arose, because we are not scientists. We are public policymakers, trying to make judgments on the best evidence, and I think that there are issues of governance and politics here and not simply issues of science or faulty science.

I have two comments: first, we and the legislature made a historic mistake in delegating this issue to the Air Resources Board when we delegated the question of whether and which oxygenates to use in gasoline. Now, this delegation was meant to take the politics out of the decisionmaking process, but, in fact, the politics simply went behind closed doors into the more dim-lit world of lobbyists, professional scientists who are paid for one side or the other—a mercenary atmosphere behind closed doors—a lobbyist atmosphere rather than a public one. I think what we've done this year is the beginning of reclaiming the issue for the political process in the legislature, and we need to make sure that the public has confidence in the process, and that's why these hearings are so important, because there's been such a closeted nature previously, through our own doing.

Second, those of us in environmental organizations to some extent were blinded by a specialization in the environmental world between air and land experts that split off air quality considerations from groundwater ones. That's not an ecological principle. Ecology would say it's a seamless whole. But when you get into lobbying in Washington or Sacramento you have to have specialists, and the air quality specialists were obsessing on how to implement the Clean Air Act. So, they joined, more or less, in a coalition with the oil industry, to achieve the standards of the Clean Air Act, not realizing or looking enough at the adverse groundwater impacts, nor even becoming concerned very much that some in the oil industry had actually created a profitable subsidiary to produce and market MTBE in order to make money off of implementation of the Clean Air Act.

I think it's time, therefore, to return to the origins of the debate and to look at it as a whole, and if MTBE can't meet the test of protecting our water, then its justification in the air is unacceptable. I think we're at that point how the industry can be compatible in its activities with protection of both air and water.

I am concerned that we not step backward from our environmental goals, and I'll simply close by noting that your hearing is taking place here while the world is meeting in Kyoto to discuss what to do about global warming. This entire issue of oxygenates, MTBE, arose in a controversy about how to achieve our clean air standards, and from the point of view of the oil industry and automobile industry, without abandoning the traditional fuel technology.

We are now back to square one, because it is projected that our nation's gasoline use is going to increase by 33 percent in the next

12 years. So, we have to look again at the issues of fuel efficiency and the alternatives that you know so well from your leadership many years ago in trying to promote conservation and renewable resources to keep our transportation system intact while protecting the air, the water, and all of our environment. In that context, reformulated gasoline may not be the answer at all but only a transitional fuel as we look for alternatives.

Thank you very, very much.

Senator BOXER. Thank you very much, Senator Hayden. I didn't assert the 5-minute rule nor will I on Senator Mountjoy. I have to say I thought your presentation was excellent because you not only put it into the immediate problem but the larger context, which is—we have to keep our eye on that at all times, and thank you.

Senator Mountjoy?

STATEMENT OF HON. RICHARD MOUNTJOY, A STATE SENATOR FROM THE STATE OF CALIFORNIA

Senator MOUNTJOY. Thank you for the hearing, and it does give the people of California a voice directly to the U.S. Congress, and we appreciate that very much.

I think Senator Hayden pretty much covered most of the aspects of what we were trying to do here in California. You know our original bill called for an outright ban of MTBE and then later, through the legislative process, 521 was watered down to a study, but a good study on MTBE. But even at the time that that went through we were saying that we believed, because of the public outcry and the poisoning of our water here in California, that MTBE would, in fact, be phased out prior to the completion of that study.

I think both Senator Hayden and I have been involved in this issue to the extent that we pretty much knew what was coming down, regardless of what the political factors were here in the State Capitol.

I have with me this morning a sample of some water, and this is from the city of Glenville. I'd like you to take a look at this and I would submit it to you, if you'd like to take that—

[Sample of water is exhibited.]

Senator BOXER. That is, seriously, drinking water?

Senator MOUNTJOY. Yes. This is out of some wells in the city of Glenville. This well is contaminated to the levels of 200,000 parts per billion. Most of the wells in that city have been contaminated to the levels of 20,000 parts per billion, hardly something—I wouldn't—well, you can smell it if you choose to, but not for too long.

Senator BOXER. If I pass out get the emergency workers in here.

Senator HAYDEN. It's part of an epidemiological study.

Senator BOXER. It's really——

Senator MOUNTJOY. Yes.

Senator BOXER. It's vile.

Senator MOUNTJOY. It has almost destroyed property values, and you have to remember that this little city is uphill from Bakersfield. Getting into the deep water aquifers and flowing downstream into Bakersfield could be very, very dangerous.

We have found that MTBE is in Lake Tahoe. A lot of this, you know, is laid off on the boats. Well, we have the boats on the lakes

and they're spewing fuel into the lakes. But you need to know that Lake Merced, in the Bay Area, is contaminated with MTBE and only has on it either boats that are rowed by hand or electric motors, so MTBE also gets in. I think you'll hear a little more about that from the geological survey folks and some of the other expert witnesses that you're going to have here today. MTBE is a threat.

In the San Gabriel Valley we have spent considerable money and time over the last 20 years cleaning up our wells from other contaminates in that valley, and now they have the threat of MTBE invading that valley, a chemical that once in the water is soluble in the water and, therefore, flows through filters, no really good way to clean MTBE out of the water.

Metropolitan Water told me that if they were to clean up MTBE—and they feel that they have to get it out of the water at the level of 5 parts per billion, and I know EPA is now saying 30 to 40 parts are safe, I believe zero is really safe.

Senator BOXER. Well, you taste it at a very low level, don't——

Senator MOUNTJOY. Yes. You taste MTBE at around 5 parts per billion. Metropolitan Water feels that they cannot sell water that you can taste, therefore, to clean MTBE out of the water their estimates are triple the water rates for the people of the Los Angeles area if they were to have to clean MTBE out of the water to the level of which you could not taste it. So, it's a very, very large threat to our water supply system in Southern California and across this State, and across the nation. We now know that it's in Texas. We've heard that high levels in, of course, Pennsylvania, and you've mentioned——

Senator BOXER. Yes.

Senator MOUNTJOY.——most all of those areas. So it is a national threat to our nation's water supply, which is very precious.

There is also the point that many of the people involved in the oil industry have said it isn't doing that much for the air, that the benefits to the air quality are very, very minute compared to the threat of the contamination of the water supply. For that reason alone I believe that the EPA should be urged to take immediate steps to either, No. 1, ban would be my, of course, first choice, or to at least relieve California of the necessity, or relieve the nation of the necessity, of oxygenating fuel at all, and try to clean it up either with another oxygenate of their choice or clean it up without any oxygenate at all, to get to the levels that are necessary.

Many of them believe they can achieve that goal, and I think they ought to be allowed to turn their experts loose to try to. Once in the water and once in the ground—you mentioned the fact, which is true—very, very, long biodegradation of MTBE. Benzene, generally speaking, 400 feet from a tank, is going to biodegrade. MTBE, not so. It will travel through the water aquifers just as it if were water.

The fact of life is that in Glenville the contamination was caused by leaking tanks and spillage of—while filling the tanks, new tanks, by the way. So we know that MTBE—it's not a question, are the tanks going to leak, it's—the question is when they're going to leak and how much are they going to leak.

We saw a pipeline over Donner Pass in which started a leak, they estimated sometime in October. It was not even detected until

March, a pipeline that had some 900 pounds of pressure in it. So we don't know the extent of the leakage in the Donner Pass area of that pipeline. So pumping MTBE through those lines is a very, very dangerous situation, and one that we believe needs to be—steps taken immediately.

I'm pleased to see companies like Tosco and Chevron are now willing to step forward and say we ought to have some alternative to MTBE because it is dangerous to our water supply.

Now, we all want clean air, and I believe we need to say on the course of attaining as clean an air as we can attain, however, at the same time we cannot afford to contaminate our precious water supply here in the State of California.

As you mentioned before, every drop of water in California is very, very precious to us and we need to do everything we can to protect our supply.

Just let me end by saying thank you so much for the hearing. I hope that our message is heard by the Congress of the United States and by the EPA, and that immediate steps are taken to stop the health risk that is going on.

Senator Hayden mentioned that there is a study ongoing, but the study involves 32 million Californians as guinea pigs, and that's something I don't believe we can afford.

Thank you again for the hearings and my chance to participate. I do have some documents from different water companies that are not going to be able to participate today, but I would like to submit these documents to you for entrance into the official record, and they are the positions of several water companies in the State of California.

Senator BOXER. It shall be done. I want to say to both senators again, thank you, from the bottom of my heart, for your leadership. If you can just stay while we hear from Mr. Perkins.

Senator MOUNTJOY. Sure will.

Senator BOXER. And then we're going to be joined just briefly, because I have one question for South Lake Tahoe. I have a couple questions for each of you. Can you stay a little bit?

Senator HAYDEN. Absolutely.

Senator BOXER. OK. Mr. Perkins. Thank you. Mr. Perkins, Craig Perkins, is the Director of Environment and Public Works Management of the city of Santa Monica. As Senator Hayden has testified and I have stated, this is why we got into this, because you came to us and we were rather stunned and shocked by your experience. If you would share a little bit of that, and try to keep it to 5 minutes, if you can.

STATEMENT OF CRAIG PERKINS, DIRECTOR OF ENVIRONMENT AND PUBLIC WORKS MANAGEMENT, CITY OF SANTA MONICA, CALIFORNIA

Mr. PERKINS. Absolutely. Good morning. In my capacity as Director of Environmental Public Works Management I'm responsible for the management of the city's water production and distribution system.

In Santa Monica, in late 1995 and early 1996, we first became aware that a new contaminant might be impacting our drinking water wells, and in early February 1996 we indeed confirmed that

several of our wells had been contaminated with MTBE. Between February and October 1996 we shut down seven of the city's 11 drinking water wells at 2 separate well fields because of this contamination. These wells, as you had noted earlier, represented 71 percent of our local water well production and supplied about one half of Santa Monica's total daily water demand.

Senator BOXER. Say how much?

Mr. PERKINS. About 50—about a half——

Senator BOXER. OK.

Mr. PERKINS.——of the total daily water demand was represented by those wells.

At the time one of the first wells was shut down the MTBE contamination had soared to 610 parts per billion, which is nearly 20 times the State action level. Clearly, the present situation represents an environmental crisis that has been a staggering blow to the city, both in financial terms and from the standpoint of an almost total loss in our local water reliability, which has been of critical importance during natural disasters such as the 1994 Northridge earthquake, where we were off of the MWD system for a full week.

As a result of the MTBE contamination, in June 1996 the Santa Monica City Council approved a 25 percent emergency surcharge on every water customer to pay for the additional $3.25 million in annual costs for the purchase of outside water to replace the lost well production. These surcharge revenues have not, however, covered the city's legal and technical analysis costs.

Santa Monica's major wellfield which is impacted, which is the Charnock wellfield, really presents a classic example of a multiple party groundwater contamination problem. The city and the State Regional Water Quality Control Board have identified 26 priority sites in the vicinity of that wellfield, including two gasoline product pipelines, which all may be sources, to a certain extent, for the MTBE contamination.

Considerable technical assessment and evaluation is required before actual cleanup can commence, and I might add that actual cleanup can also not commence until we determine the—an effective, cost-effective and reliable means of cleanup, which is a major research project in itself. The Arcadia wellfield is the other location which has been impacted by MTBE, and at this cite there is only one party, Mobil Oil, which has caused the contamination.

What was particularly difficult to deal with during the early stages of this episode were the significant gaps in information about the potential public health and environmental impacts from MTBE as a water contaminate, and the distressing absence of technical and regulatory assistance from those State and Federal agencies, which are entrusted with oversight of water quality and groundwater protection issues.

As local government officials we were forced to arrive at our own conclusions about whether MTBE contamination—contaminated water should be delivered to our customers because no enforceable water quality standards for MTBE existed in early 1996, and still do not exist. In the face of this vacuum we made the decision to shut down the wells in order to err on the side of public health protection for our community.

Following negotiations, which lasted many months, with oil companies, with the two oil companies who exercised a good corporate responsibility and stepped forward to discuss the problem with us, we entered into an interim agreement with Shell and Chevron in July 1997, which has reimbursed us for 75 percent of the MTBE costs associated with the Charnock wellfield. This interim agreement enabled our City Council to reduce the emergency surcharge by one-half, which they did last—this July.

The agreement expires in January 1998, unless these and the oil companies who may be responsible, renew the agreement at 100 percent reimbursement rate. So it remains to be seen whether, in fact, this agreement will be able to continue past January.

At Arcadia, ironically, where the culpability of Mobil Oil is clear, negotiations between the city and Mobil broke down approximately a year ago, resulting in a lawsuit filed by the city in February 1997, which is being pursued by the city in the face of continued recalcitrance on the part of Mobil to admit any responsibility for the problem.

It's become clear to us in Santa Monica that MTBE is indeed a potent and pernicious threat to drinking water in California and other parts of the United States. Although MTBE has only been in widespread use since the early 1990's, and even though testing for MTBE has not been required until very recently, MTBE has now been found in almost 4 percent of California drinking water systems that have been sampled.

We believe that these findings represent the tip of the iceberg in terms of the MTBE that may be on its way. It's important to note that benzene, which has been a constituent in gasoline for several decades, is rarely detected in wells, yet MTBE, in just a few short years, has already managed to knock out 71 percent of Santa Monica's wells alone.

We will eventually overcome this crisis, but actions can be taken at the State and Federal level which could greatly facilitate our progress on the path toward restoration of our drinking water supply.

I'd like to close by mentioning what we believe can be done at the Federal level: First, adoption of clear and enforceable drinking water standards for MTBE by the earliest possible date;

Second, strengthening of installation monitoring and testing requirements for underground gasoline storage tanks and pipelines to respond to MTBE's more alarming fate in transport characteristics;

Three, adoption of strict liability standards for those responsible for MTBE contamination to ensure that the polluter and not the victim pays for damages and cleanup costs;

Fourth, implementation of testing requirements for MTBE at all leaking underground storage tanks and in all public drinking water supplies throughout the United States, so that we can know as soon as possible how big a problem we're really dealing with and can better prevent the replication of Santa Monica's problem throughout the rest of the nation;

And, finally, evaluation of whether performance-based clean air standards for auto fuel would be more appropriate than the current mandate for the use of oxygenates.

In closing, on behalf of the city of Santa Monica, I'd like to thank you, Senator Boxer, for the tremendous past support you've given to us, and I look forward to further collaboration with you and your staff so that we can truly achieve comprehensive solutions. Thank you.

Senator BOXER. Thank you, Mr. Perkins, very much.

I—you know, city of Santa Monica found itself in this leadership role quite accidentally and not wanting to do this. You had to work without any information, and I understand it that in some of your wells here there was 610 parts per billion found——

Mr. PERKINS. That's correct.

Senator BOXER.——of MTBE. And we didn't know anything, and just now we have an advisory that says maximum 40 parts. You acted wisely, you protected the health of your people, and I just want to thank you for exercising that leadership, and tell the mayor and the entire council that—well, they know I feel this way, but tell them again.

The other thing is, you point out 4 percent in California—four percent of the California drinking water wells are contaminated with MTBE, those that—at least those that have tested—been tested for it. Nationwide it's 8 percent. So this is a national problem. You know, I would like to believe that because of all of our efforts, and others, the community, that we just sort of said time out and we got to stop it here and clean it up and not have it occur again, because it's a frightening issue staring us in the face.

I wanted to ask Rick Hydrick from South Lake Tahoe to join us. I have just a question for you.

In the meantime, Senator Hayden, let me lead off with a question for you and Senator Mountjoy and however—whoever wants to speak first. Do either of you think that stopping the leaking underground storage tanks and pipelines is the solution to the MTBE problem?

Senator HAYDEN. Well, it certainly should be done, whether they're double-walled or whatever, and there are State and Federal laws which require the upgrade of those installed devices. There is some evidence, however, that MTBE is tenacious and can make its way through these walls. I'm not here to say that I've drawn a conclusion, but there's certainly evidence from Santa Monica, whose underground tanks were in good shape.

There's also the fact that cannot be forgotten, that a certain percentage, small, but over time it accumulates, is emitted into the atmosphere. It's not emitted into a tank, it's emitted into the atmosphere and falls on the soil, or falls on lakes. It's also in the thousands, tens of thousands of boats that Dick Mountjoy uses to try to take us fishing, you know, it's like the motorists.

It's not yet a chemical compound that seems to be controllable with a nice device, like an underground tank, not that we shouldn't move forward for other reasons to protect ourselves with the underground tanks.

Senator BOXER. OK. Senator Mountjoy?

Senator MOUNTJOY. I really believe that the underground tank improvement program is an essential program, because regardless of what is in the tank——

Senator HAYDEN. Right.

Senator MOUNTJOY.——however, MTBE is a different product, and MTBE seems to be able to escape from those tanks regardless of the viability of the tank, and, so—and there are other ways that MTBE gets into the water system, through—and you're going to hear more about that.

But I really believe that just the rebuilding of the tank is not the solution to our problem with MTBE. I think our solution should be that we go to another product, or cleaner burning fuel without oxygenate, and let the scientific world work on cleaning the fuel without MTBE. I don't see any reason for a continued threat of MTBE. We have a problem, and as was noted, we have used benzene for a number of years and yet only in a very short period of time, where benzene has not really been contaminating our well, because of the biodegradation of it——

Senator BOXER. Yes.

Senator MOUNTJOY.——very rapidly. MTBE is different. I said that before. MTBE, once in the soil, continues to move. It does not biodegrade. Therein lies the problem, and I think our real solution is to just step back for a moment and really eliminate MTBE from the fuel, I think would be the safest and most prudent step that we would take. I know that's a little strong stand but I think it's a right stand to take. As you can see in the appearance of Senator Hayden and mine on this same subject, we're hardly on the same spectrum politically, but this is not a political question nor is it a partisan question. This is a question of health, and that's why you will see people from all spectrums be on the same side on this issue, because it is a question of health and not one of politics.

Senator BOXER. Exactly.

Mr. Hydrick, from South Lake Tahoe, could you comment? Because I had some conversations with you before and my concern has been alluded to by Senators Hayden and Mountjoy that MTBE can corrode through even a tank that's in good condition. Do you have any experience with that issue up there in Tahoe?

Mr. HYDRICK. We have five wells that are—two are contaminated already and three are imminently threatened with contamination.

Senator BOXER. You have three wells currently contaminated with MTBE?

Mr. HYDRICK. No, two contaminated——

Senator BOXER. Two.

Mr. HYDRICK.——and three imminently threatened——

Senator BOXER. OK.

Mr. HYDRICK.——by pollutants of MTBE. The source of the MTBE appears in three of those cases to be from new tanks. Our Regional Board agrees with us on that.

Senator BOXER. New tanks, meaning how old are these tanks?

Mr. HYDRICK. They've been put in in the last couple of years, few years, to meet the 1998 standards for dual wall tanks and pipe distribution systems.

Senator BOXER. So I think it's really important that the EPA hears this, because in my original conversations with EPA, when this first came to my attention, the immediate response was it's not an MTBE problem, it's a tank problem.

What I would like to say today, from the most credible sources, is that I think we've—that's not accurate, and we have a problem

with MTBE. It appears to be—it appears to corrode through even new tanks.

Mr. HYDRICK. It appears to be escaping from new tanks.

Senator BOXER. Right.

Mr. Perkins, do you have anything to add on this question?

Mr. PERKINS. In terms of the tank issue, and, of course, the pipeline issue, which is a whole other realm of discussion which merits a lot of attention, but there is no such thing as a leakproof tank. It's sort of like trying to achieve cold fusion. It's just not going to occur. Right now the experience is in the United States 23 percent of all underground storage tanks have leaked at some point, and with the new systems maybe that's going to be reduced, but it certainly is not going to be eliminated. So it's a continued concern that fuel will escape from tanks.

Senator BOXER. Now, this product that was given to me by Senator Mountjoy, is this similar to what the water looked like in Santa Monica at its worst or——

Mr. PERKINS. Well, the—one of the characteristics of MTBE is that it's colorless, so that—so the brown color is from other minerals and other—

Senator BOXER. OK.

Mr. PERKINS.——things in the water. But the sample which we took at 600 parts per billion was—had the distinct turpentine odor.

Senator BOXER. A similar odor to this.

Mr. PERKINS. Very similar, yes.

Senator BOXER. So that, clearly, people smell it and taste it at very low levels. So what's going to happen is people—even if, let's say, we found out the news tomorrow that MTBE made you smarter and stopped Alzheimer's, the fact is it tastes terrible and people aren't going to trust it. Pretty smart instinct we have there, when something tastes bad is to reject it.

Senator MOUNTJOY. Believe me, it won't cure Alzheimer's, it'll give you Alzheimer's.

Senator BOXER. Well, let's not have that be the headline to——

Senator MOUNTJOY. Listening to some of the testimony of the truck drivers and people that deliver it, Senator, have said that—one person came in and said he couldn't remember the last station that he fueled, and sometimes had to pull his truck off to the side because of the fumes that he injected——

Senator BOXER. The fumes.

Senator MOUNTJOY.——while fueling at a gas station. So it's very——

Senator BOXER. Well, actually, we got those reports from Alaska; is that right, Linda?

[Nodding affirmatively.]

Senator BOXER. That in Alaska that's how they first noticed it, was when people were pumping they smelled it and they ascertained it was the MTBE.

Senator MOUNTJOY. And the reason for the discoloration is the fact that MTBE, as traveling through the ground, will drag with it other——

Senator BOXER. Yes.

Senator MOUNTJOY.——minerals that otherwise wouldn't have been in the water.

Senator BOXER. And that's what you think——

Senator MOUNTJOY. Right. Sure. Of course.

Senator BOXER.——is responsible for the coloration here.

Well, I just want to really thank you all again for your leadership, for hanging in there in California, and I want to be the best senator I can be, and that means working with you on this. So I really hope that you will let me know what more I can do and the way we can be a partner in this, because we're all in this together, and California's always on the cutting edge, I'm very proud to say, of many issues. We're really on the cutting edge of this one, and I will take this news back to my colleagues.

Is there anything else you want to say before we go to panel No. 2?

Senator HAYDEN. I would hope, Senator, that you understand how important your hearings are, because this is a wider issue than Santa Monica or the State.

Senator BOXER. Right.

Senator HAYDEN. Second, that you look at the neurotoxicity and not just the cancer-causing potential, because neurotoxicity causes invisible effects on the most intimate of organs, our nervous system, our brain.

And, third, I hope that you will resume your longstanding interest in alternative fuels and fuel efficiency, as Mr. Perkins said. Thank you so much for doing this.

Senator BOXER. I have introduced bills, one of which passed, to begin to do more purchasing of electric vehicles and alternative fuel vehicles, through Department of Defense and other ways, so that we can begin finally to get to the root cause of all this, but—Senator Mountjoy?

Senator MOUNTJOY. Senator, if you need any help in a nudge for some of your colleagues in Washington, DC.——

Senator BOXER. Yes.

Senator MOUNTJOY.——or a kick in the pants, I'm sure Senator Hayden and I'd be willing to assist in that regard, so——

Senator BOXER. Well, I will remember that.

Senator MOUNTJOY. OK.

Senator BOXER. I will so note that. I thank you on behalf of my chairman, John Chafee, and thank you very, very much.

We will ask panel two to come up and join us. It's Cynthia Dougherty, Director, Office of Groundwater and Drinking Water, of the Environmental Protection Agency, accompanied by Julie Anderson of Region IX; and U.S. Geological Survey, John Zogorski, Chief of National Synthesis on Volatile Organic Compounds and MTBE, accompanied by Michael Shulters; and CAL-EPA's Peter Rooney, who's the Secretary; and California Department of Health Services, Dr. David Spath, who is the Chief of Drinking Water and Environmental Management Division; and Stephen Hall, Executive Director of the Association of California Water Agencies.

We have a large panel. I'm assuming the people who are accompanying our speakers will be there not to make an opening statement but to have background, and so we can move through. It's wonderful to see all of you here. Because of time constraints, although I think we're moving ahead, if you could keep your comments to 5 minutes and we'll try to move you along.

I would ask that Cynthia Dougherty, Director, Office of Groundwater and Drinking Water, of the Environmental Protection Agency, to begin. I want to thank her for coming today. I am very pleased she's here. Obviously, she's going to play a very important role in reporting back to Secretary Carol Browner about our hearing today. I would like to make a special packet up for the Administrator so she gets all the up-to-date information.

Won't you begin, Cynthia Dougherty, and thank you very much for being here.

STATEMENT OF CYNTHIA DOUGHERTY, DIRECTOR, OFFICE OF GROUNDWATER AND DRINKING WATER, U.S. ENVIRONMENTAL PROTECTION AGENCY; ACCOMPANIED BY: JULIE ANDERSON, REGION IX RCRA OFFICE, MANAGER OF MTBE TEAM

Ms. DOUGHERTY. Thank you, Senator Boxer, and I'll be happy to take anything back to Carol Browner that you'd like me to take.

I am pleased to be here to talk about issues and activities that the EPA's undertaking regarding MTBE issues, chiefly, and MTBE in water. The panel before us talked a lot about what has been happening in California, and the issues in California have particularly raised concerns across the country regarding the occurrence of MTBE in drinking water supplies and have helped us to move ahead with some concerns that we've been trying to address.

The Federal Government's addressed questions about MTBE on many fronts, including work to accurately understand and characterize the scientific and policy issues, of which there are many, that we don't have answers for yet.

With respect to drinking water, this work will substantially improve our knowledge of the occurrence, the potential for human exposure, and the health effects of MTBE in drinking water sources across the country.

This week—as you mentioned in your opening remarks—the EPA made available a drinking water advisory on MTBE to provide guidance and information to States and local communities as they make important water supply and management decisions if MTBE is detected in their drinking water supply, and, hopefully, also before it's detected in their drinking water supply.

My written testimony covers the background on reformulated gasoline and the air program, and also talks about the Office of Science and Technology Policy Report that came out this past year. I want to briefly focus in my comments now on several activities underway which relate particularly to MTBE in water and what the Agency's doing.

First, in terms of research, the Agency has underway—out for public comment now—some work related to Section 211 of the Clean Air Act, research that will be done by the industry that's going to be looking at neurotoxicity and carcinogenicity tests on animals for both conventional and MTBE gasoline. The comment period on that closes on January 9, and the key purpose of that research is to provide necessary data to conduct a comparative risk assessment between conventional and MTBE gasoline, which you had talked about in your opening remarks. We'll hope to be able

to use that work on the air side to extrapolate that to look at effects in terms of drinking water.

As a result of the White House Office of Science and Technology Policy Report the EPA's formed an agency-wide task force to develop a research strategy for oxygenates in the water. The strategy is going to identify ongoing research that we have, as well as research still to be started, in areas that include environmental occurrence, source characterizations, transport and transformation, exposure toxicity and remediation. That research will be coordinated with at least four different offices, and the EPA will be working with the U.S. Geological Survey on some of the work, particularly in the occurrence area, and hope to be able to build a stronger data base that we can use to really assess what's happening nationwide, and what the effects might be of oxygenates in water.

In October, related to that research strategy, we convened a meeting of 50 experts from outside the Agency, other Federal agencies, academia, and to review the draft that we had, and hope to have that draft out for public comment in January. So we'll be moving ahead. A lot of that research—not a lot, but quite a bit of research is already underway and there will be more still to come that we'll be working on.

Second, related to the Resource Conservation Recovery Act—and I have Lester Carlton here, actually, from our San Francisco Regional Office, who's an expert in the underground storage tank program. EPA has ongoing efforts under the underground storage tank program under RCRA Title I to prevent further contamination of water supplies by petroleum, including petroleum with MTBE.

The primary source of MTBE detections at high concentrations is leaking underground storage tanks and possibly transmission facilities, and that's what the underground storage tank is meant to deal with. There are about a million underground storage tanks in use in the United States that are subject to the underground storage tank program and regulations. Existing tanks, as was stated earlier, are required to be upgraded, replaced or closed by December 1998 to meet the spill overfill and corrosion requirements of Federal law, and in California they're also required to be lined or doublelined.

Right now our estimate in terms of progress in doing that is that half the tanks have been upgraded or replaced and are now in compliance with the 1998 deadline. The EPA regional offices are working with each State to help develop State specific plans to ensure that we get compliance and that where there isn't compliance by that December 1998 date, that either the State or EPA is taking appropriate enforcement action to make sure that those tanks are upgraded.

The third area that I wanted to talk about is what we're doing under the new authorities of the Safe Drinking Water Act, which you're quite familiar with since you and your committee were leaders in getting the Act reauthorized.

There are a number of new authorities under the Safe Drinking Water Act that we're using to try and locate MTBE and decide what we should do. First, the amendments require EPA to publish a list of contaminants that may require regulation based on their known or anticipated occurrence in public water systems, and then

require EPA to go through a risk and science-based process defined in the law to consider them for potential regulation.

As you stated in your opening remarks, MTBE is on the draft of that list that we put out in October, and we expect to finalize that list in February 1998, and that list will then be used by us to determine where to focus our research efforts, where to focus our data-gathering efforts, and where to move ahead to start developing regulations for contaminants that we haven't yet regulated.

We are required under the law to make a determination as to whether or not to regulate five contaminants on that list by no later than 2001. So there's a long process that we go through in terms of working through what we have to do there. We do have authority to do interim regulations where there's an urgent health need to do that. That allows us to skip some steps and then go back and do those after we've regulated.

Also under the Safe Drinking Water Act one of the particularly new parts of the Act is source water assessment requirements on the States, where States are required to do source water assessments to determine the vulnerability of the State's community water supplies to different threats of contamination, including——

Senator BOXER. Can you wrap up at this point?

Ms. DOUGHERTY. OK. We think that that program along—done together with underground storage tanks should help a lot.

The thing that I wanted to most talk about, but haven't gotten to, obviously, is the drinking water advisory that we put out. Let me just say really briefly——

Senator BOXER. Go ahead.

Ms. DOUGHERTY.——that that advisory sets out a level of 20 to 40 micrograms per liter that we believe, if MTBE is kept at that level to protect consumer acceptance based on the taste and odor responses that people have had, that that will also provide a large margin of safety from any potential health effects, and is actually 20,000 to 100,000 times lower than the range of exposure levels to which cancer and noncancer effects were observed in the rodent test, which is level of margin of safety that's consistent with what we normally apply in doing our national drinking water standards, if we should do a national standard.

In conclusion, EPA's deeply involved in a range of different activities related to dealing with the MTBE in water issues. We take very seriously concerns that systems and States have in terms of MTBE contamination in drinking water and we intend to address it to try—but using, as Congress told us to do, making sure that we have good data and making sure that we have sound, peer-reviewed science as we make those decisions.

Senator BOXER. Thank you. Thank you very much.

Now we'll have the USGS, John Zogorski. Welcome.

STATEMENT OF JOHN ZOGORSKI, CHIEF OF NATIONAL SYNTHESIS ON VOLATILE ORGANIC COMPOUNDS AND MTBE, U.S. GEOLOGICAL SURVEY; ACCOMPANIED BY: MICHAEL SHULTERS, CHIEF, CALIFORNIA STATE WATER RESOURCES DISTRICT

Mr. ZOGORSKI. Thank you. Senator Boxer, I appreciate the opportunity to appear before you today to testify on methyl tertiary butyl

ether. My name is John Zogorski and I'm a hydrologist with the U.S. Geological Survey.

As you may know, the mission of the Geological Survey is to assess the quantity and quality of the earth's resources and to provide scientific information that will assist resource managers and policymakers. Assessment of water quality conditions and trends, it is an important part of our overall mission.

I am currently working on our National Water Quality Assessment Program, often referred to as NWQA. More specifically, I'm responsible for a team of hydrologists who are synthesizing, interpreting, and reporting information on volatile organic compounds in the nation's groundwater and surface water.

MTBE is one of about 60 volatile organic compounds that we are assessing. The main building blocks of our assessments are comprehensive water quality studies of more than 50 large river basins and aquifers across the nation. The San Joaquin, Sacramento, and Santa Ana river basins in California are three of the study areas we have or will assess.

In 1995 the Geological Survey published a report discussing the occurrence of MTBE in shallow groundwater, based on our first NWQA results. Chloroform and MTBE were the two most frequently detected volatile organic compounds in about 700 shallow wells. MTBE was detected in about 25 percent of the urban wells and about 1 percent of the agricultural wells.

Senator BOXER. Could you say that again?

Mr. ZOGORSKI. Yes. MTBE was detected in about 25 percent of the urban wells and 1 percent of the agricultural wells.

Senator BOXER. Thank you.

Mr. ZOGORSKI. It's important to note that 3 percent of the wells sampled in urban areas had concentrations of MTBE that exceeded the Federal drinking water health advisory. This initial sampling did not include urban areas in California. An urban groundwater study is a component of the Sacramento River Basin Study, and our data collection in Sacramento will be completed this year.

Last year I co-chaired a Federal interagency panel to summarize what is known about fuel oxygenates in water quality. The results of our effort were published as a chapter in a report entitled "Interagency Assessment of Oxygenated Fuels." The water quality chapter summarizes the scientific literature and agency data for groundwater and surface water.

Further, we discussed the implications for drinking water quality and aquatic life, and we identified areas where the data are too limited to make definitive scientific statements. Recommendations were made that we believe would reduce uncertainties and allow a more thorough assessment of human exposure, health risk and benefits, and environmental effects.

Because of the very limited data sets for MTBE in drinking water it was not possible for our panel to describe MTBE's occurrence in drinking water for the nation. Similarly, there was not sufficient data on MTBE to establish a Federal criteria to protect aquatic life.

Our panel did conclude that drinking water supplied from groundwater is a potential route of human exposure to MTBE. Based on limited monitoring in five States, including New Jersey,

Iowa, Illinois, Colorado and Texas, MTBE was detected in 51 public drinking water systems through 1996. However, when detected, the concentrations of MTBE were, for the most part, below the Federal health advisory. This indicates that the consumption of drinking water was not a major route of exposure for these few systems. In a few instances, high concentrations of MTBE in groundwater have caused the shutdown of drinking water production wells. The source of contamination in most cases is believed to be releases from gasoline storage tanks.

Finally, I'd like to briefly summarize the three broad recommendation of our panel:

First, completing a drinking water exposure assessment should be given high priority. Monitoring of MTBE in drinking water for this purpose should initially be targeted to high MTBE use areas, and to those environmental settings that are otherwise sought—thought—excuse me, to be more susceptible to contamination.

Second, additional studies are needed to expand the current understanding of the sources, environmental behavior, and shade of MTBE so as to identify environmental settings and situations where MTBE will be of concern.

Finally, studies of the aquatic toxicity of MTBE are needed to define the extent of any threat to aquatic life and to form the basis of a Federal water quality criteria if warranted.

Again, the Geological Survey appreciates the opportunity to testify at this hearing, and I'd be happy to answer any questions that you have.

Senator BOXER. Thank you very much. I have this, and I find it very important. Just quickly, this is done by the President's task force? Who actually put this together? This is interagency?

Mr. ZOGORSKI. This was coordinated by the Office of Science and Technology policy. There was a variety of organizations involved. In terms of the water quality chapter, there were representatives from EPA, USGS, Texaco, the American Petroleum Institute, Oakridge, and the academic community.

Senator BOXER. It's very, very helpful. Thank you.

Secretary Peter Rooney from CAL-EPA. We welcome you and we thank you for being here with us. Go right ahead.

STATEMENT OF PETER M. ROONEY, SECRETARY, CAL-EPA

Mr. ROONEY. Thank you, Senator. As you say, I'm—I am serving——

Senator BOXER. Would you come closer to the microphone? That's right.

Mr. ROONEY. Let's see. I'm probably using this one.

Senator BOXER. That's terrific. Good.

Mr. ROONEY. Good morning, Senator. Thank you very much for convening these hearings and giving us an opportunity to speak with you about it.

We feel it is impossible to talk about this issue without first discussing why it is being used as a gasoline additive. As you mentioned in your opening remarks, it is an oxygenate which is blended in our reformulated gasolines to help dilute volumes of benzene, sulphur, aromatics, olefins, and other undesirable compounds. During the winter months areas throughout the United States that are

in violation of carbon monoxide standards use oxygenates to help reduce tailpipe carbon monoxide emissions.

But it's interesting and it's important to note that no Federal law regulation and no State law or regulation mandates the use of MTBE. In fact, California's cleaner burning gasoline regulations provide the refining industry with the ultimate flexibility. As long as the performance standards are met and as long as the emission reductions are realized, California regulations allow cleaner burning gasoline to be made without any oxygenate at all.

The Federal Clean Air Act specifically preempts that flexibility, however. That's why Governor Wilson's administration has been on record for 2 years in support of efforts by Representative Brian Bilbray that would remove the year-round oxygenate mandate from the Federal Clean Air Act, at least with respect to California. I'm also pleased to note that your colleague, Senator Feinstein, has recently announced that she will introduce a companion bill in the Senate this January.

At the State level the State Water Board does administer the underground storage tank program, as well as the underground storage tank cleanup fund. The underground storage tank program includes both leak prevention and cleanup when leaks occur. California State law provided a 10-year compliance period for all regulated underground storage tanks to be removed, upgraded or replaced, in accordance with both State and Federal standards, and that target date is by December 22, 1998.

There are currently some 65,000 operating underground storage tanks in California located at 25,000 facilities. An estimated 43 percent still need to be removed, upgraded or replaced. The State Board and local implementing agencies have pursued aggressive efforts to ensure that the 1998 State and Federal upgrade deadline is met, including having met with each State agency that operates underground storage tanks to obtain a commitment from each of those agencies that the 1998 deadline will be met. We're hopeful that Federal agencies will match our commitment. At this point I have no information whether the Federal process is on track.

To further ensure compliance with the underground storage deadline the administration proposed, and Governor Wilson signed, AB1491, which you had mentioned earlier, authored by Assembly Member Cunneen. This law will prohibit the delivery of fuel to underground storage tanks which do not comply with the upgrade standards after January 1, 1999. The bill underscores California's commitment to prevent future leaks from underground storage tanks.

In the cleanup fund, which was established in 1991, to provide financial assistance for eligible cleanup costs and damages awarded to injured third parties, to date more than $500 million has been distributed under this program and the fund has collected some $700 million.

In 1995 the Water Board ordered sampling after hearing of the results from the geologic survey, and it showed that most of the leaking sites had detectable levels of MTBE in shallow groundwater. These results were found about the same time as the finding of high levels of MTBE in the public drinking water wells in the city of Santa Monica.

In the spring of 1996 the State Board requested all regulatory agencies involved in leaking underground cleanups to add MTBE to routine monitoring wells analysis. In addition, the State Board, with funding from the U.S. Department of Energy and the Western States Petroleum Association, contracted with Lawrence Livermore National Laboratory to conduct a study on the environmental fate of MTBE in groundwater. That study should be——

Senator BOXER. Could you wrap up just this next minute or so?

Mr. ROONEY. I will. As was mentioned, the legislature passed four bills this year. The Governor signed all four. The Governor, in signing, also directed that the State Board determine and investigate the issue that was raised here this morning of whether or not the new converted tanks are also leaking tanks, and that study will be pushed forward with maximum speed to see if that is a new factor in this equation.

Also, the Governor asked that the Energy Commission study the possible ramifications of various scenarios of changing the use of MTBE, and directed that the marina operations be examined.

In conclusion, I think the choice should be left to refiners in what can be done. I would ask you for your support in the Bilbray/Feinstein legislation. That would bring back to California the flexibility to devise a fuel system that does not necessarily require any oxygenate and will solve our air problems but at the same time protect our water supply. So thank you very much for having these hearings today.

Senator BOXER. Thank you so much, Secretary Rooney. My committee is looking at that bill, the Committee on Environment and Public Works. But my focus is MTBE and I don't really want to wait around, if we find it's really such a risk, for a bill to go through opening up the Clean Air Act. It takes a long time, as you know, for a bill to become a law. My view is that if we find the danger from MTBE outweighs the benefits, we don't want to wait around for a bill.

I'm happy to look at a bill that deals with oxygenates and other mandates. That's not a problem. We do have ethanol, which is an oxygenate, but does not cause some of these problems. I'm going to ask you more about that, if there's any adverse impacts from ethanol. But, the issue today is MTBE and what steps we can take immediately. I'm studying this bill, as is my chairman, Chairman Chafee, and I can assure you that we're going to take swift action on this whole matter.

I want to praise you and the Governor for signing these bills, and, particularly, I think this study on whether or not even the new tanks are at risk is key, because if people are going to invest all this money in new tanks only to find out that they're leaking again, I think it would be a disastrous decision, and we need to have this information. So how soon do you think you may have that information?

Mr. ROONEY. The Governor has asked the Water Board to convene the panel of experts immediately.

Senator BOXER. Good.

Mr. ROONEY. We would hope in due course, and shortly in due course, that we would have the best judgment that we can come up with.

Senator BOXER. Well, it would be extremely helpful to all of us if California can move forward on this. I know that you will, so thank you very much.

Our next speaker is Dr. David Spath, Chief, Drinking Water and Environmental Management Division of California's Department of Health Services. We welcome you.

STATEMENT OF DAVID SPATH, CHIEF, DRINKING WATER AND ENVIRONMENTAL MANAGEMENT DIVISION, CAL-EPA

Mr. SPATH. Thank you, Senator Boxer. Appreciate the opportunity to come before you and describe the efforts of the Department to determine the extent of contamination of drinking water supplies, and also to describe our efforts in regulating MTBE under recently mandated State laws.

As you've heard already, we have an action level of 35 parts per billion of—for MTBE, and just briefly, that's an advisory level, as it is with EPA. We use it to advise water systems that if they exceed that level, that they should not serve that water to the public, as we advised the city of Santa Monica when they found excessive levels of MTBE.

Senator BOXER. And what was your level that you picked?

Mr. SPATH. Thirty five parts per billion.

Senator BOXER. OK.

Mr. SPATH. In 1996, based on scientific literature, USGS literature, and others, indicating that MTBE could be a groundwater contaminant, we alerted all public water systems of the necessity to evaluate their sources for potential contamination from MTBE, and also advised them that we would be regulating MTBE as what is called an unregulated contaminant.

In February 13, 1997, we established an unregulated monitoring requirement for MTBE that would affect 4,400 water systems with approximately 11,000 sources. To date we've had results from 479 water systems, which represents more than 2,400 sources. Within that group 17 systems have reported MTBE findings, which represents 27 sources. Fifteen of those are groundwater sources and 12 are surface water sources.

Two water systems have reported levels above our action level. You've heard city of Santa Monica, also a system in Marysville, California. A water service company has also reported one well in excess of that level.

With regard to setting drinking water standards for MTBE, Senator Hayden and Assemblywoman Kuehl both authored legislation last year that required the Department to establish a primary drinking water standard by July 1999, and a secondary drinking water standard of July 1998.

We've already begun the work on the secondary standard and have drafted a rule for that standard. It is now going under administrative review. The studies to date on taste and odor show that concentrations as low as two to two and a half parts per billion will elicit taste and odors with regard to MTBE. So there are—there is a portion of the population that is quite sensitive to MTBE. It varies, obviously, but you can see that the concentrations could be quite low. Our draft regulation is at five parts per billion, and that's what we will be recommending to go forth with.

With regard to the primary drinking water standard, the health advisory we have right now is based on noncarcinogenic effects. The chemical is demonstrated to be a carcinogen through inhalation. The chemical, however, is, to date, not demonstrated to be a carcinogen through ingestion, and studies are still going on to determine whether that is going to be an outcome of the chemical or not.

Finally, I'd like to——

Senator BOXER. So we don't know at this point if it causes cancer if it's ingested.

Mr. SPATH. That's right. There are studies. There was an Italian study. that has not been peer-reviewed, that suggests that to be the case, but it's still an open question.

Senator BOXER. So, actually, no scientist who has read all the papers could say that it causes cancer or it does not. We——

Mr. SPATH. Through ingestion.

Senator BOXER. Through ingestion.

Mr. SPATH. That's right.

Senator BOXER. Which is what we're talking about here——

Mr. SPATH. Right.

Senator BOXER.——the drinking water.

Mr. SPATH. That's correct.

Finally, I'd like to reiterate Cynthia Dougherty's comments with regard to the Source Water Assessment and Protection Program, which has been envisioned of the Federal Safe Drinking Water Act, and is also part of the State law. The Department has already begun the process, in coordination with Federal, State and local agencies, to develop a plan that we will be submitting to the Environmental Protection Agency in mid 1998, which will describe our program for assessing and protecting public water supplies throughout the State. We're hoping that that'll be approved and over the next three or 4 years we will implement that program.

And, finally, as the Federal and State laws envision, we're hoping that local agencies, through their voluntary program, and potentially through funding from the State revolving fund, which is part of the Federal Act, that local agencies will undertake these voluntary programs to protect their local sources. We think this is a very important aspect of the overall law and will bring the public close to the real need for protecting public water supplies, regardless of whether it's from MTBE contamination or other sources.

In closing, I'd like to thank you for the opportunity to present this information. As I said, we will be going forth jointly with establishing standards within the next 2 years and we'll be regulating public water systems in concert with the Federal agency.

Senator BOXER. Thank you, Doctor, for your very important statements.

We're going to call on Mr. Stephen Hall, who it's my pleasure to work with on so many important issues, including the wonderful Cal Fed process which we're all trying to make a success.

Before he speaks, I just want to tell everyone in the audience and the press what the plan is. I'm going to ask questions of this panel, then we're going to take a quick 10 minute break. Then we're going to come back and hear our public health panelist, Dr. Brautbar, from the UC School of Medicine; Nancy Balter, Ph.D.,

former associate professor from Georgetown University. She's the principal at the Center for Environmental Health and Human Toxicology, and Mr. Gary Patton, Counsel for the Planning and Conservation League. That will complete our program.

I'm very happy to call on Stephen Hall at this time.

STATEMENT OF STEPHEN K. HALL, EXECUTIVE DIRECTOR, ASSOCIATION OF CALIFORNIA WATER AGENCIES

Mr. HALL. Thank you, Senator. We do have extensive written testimony which I'd request be entered into the record.

Senator BOXER. So ordered.

Mr. HALL. And I would like to also request that testimony from Judy Abdo, on behalf of the Metropolitan Water District of Southern California, also be entered into the record.

Senator BOXER. Without objection, so ordered.

Mr. HALL. Thank you. Thank you for the opportunity to present oral testimony.

I represent the folks who deliver water to the public. It's our job to deliver water which is safe and which the customer believes it's safe. That is not always easy, and with MTBE it just got a lot harder. We don't think customers should have to think twice about the safety of their drinking water, but, unfortunately, with a compound such as MTBE, they can detect it at such low levels through taste and odor that it will be virtually impossible to deliver water that the customer has confidence in, the public has confidence in, if we do not act soon to remediate contaminated water and to prevent further contamination.

We don't know a lot about MTBE but what we know is bad news. You've heard ample evidence of that this morning. There is potential for widespread contamination. Gasoline is used virtually everywhere in California. There are literally thousands of pipelines carrying gasoline across the State. It is soluble in water. It moves faster than most of the compounds in gasoline. It doesn't biodegrade. It's no surprise, then, that it is already finding its way into surface water and well water. We've sampled a small fraction of the wells in California and we're finding it in lots of places, as you heard this morning.

It's difficult to treat. There is no established treatment technology. It can probably be treated with existing technologies, but it will be very expensive. There are literally thousands of wells in California. Early estimates are one million to a million and a half per well to install the equipment, and at $100,000 per year to operate it. We simply cannot afford to treat for MTBE in every well in California.

The greatest threat is to groundwater, but there is also threat to surface water. Now, in groundwater 40 percent, on an average basis, of our water comes from the ground. In dry years that goes up to 60 percent. More importantly, some communities have to rely exclusively on groundwater. They have no other source of supply. So if it becomes contaminated they and their customers literally have no option except to do without or to treat it at very high cost.

We—our organization has begun conducting a survey, an occurrence survey, in the surface reservoirs that our members own and

operate to determine how much MTBE is in their surface water and to what extent it is statewide.

We know that customers can smell and taste it as low as 2.5 parts per billion, as Dr. Spath indicated, so there is a potential for a real crisis of confidence in our public drinking water supplies. There are no more safe drinking water supplies anywhere in the world than in California, but if the public can taste and smell compounds in their drinking water it will be virtually impossible to convince them of that, regardless of the real public health risks, and we know that there are some potential public health risks. Our members are already getting concerned calls from their customers about MTBE. Even where it doesn't exist in the drinking water supply the public has read about it. They're worried about it.

Senator to us this seems to be a classic case of the law of unintended consequences being applied. Anybody who lives in California not only breathes the air, they can often see the air. So the air quality problems are real and they're visible, however, this is a case where a product was rushed to the market without appropriate study to determine its unintended consequences, and as a result, in an effort to clean up the air, we have polluted the water. We now have a potentially huge environmental and potential public health problem. The cost of remediating that problem is incalculable, but huge.

I want to emphasize, we're not here to simply point fingers. The water community is ready, willing and able to help solve the problem. In fact, we've already started. We're already working with the petroleum industry to work on treatment technologies.

I mentioned the occurrence survey that we're doing to determine the extent of it in surface reservoirs. We supported the legislation last year on MTBE that was passed by the legislature and signed by the Governor. Now I need to ask for your help, Senator. We need help from the Federal Government, and having worked with you on Cal Fed I know how effective you can be in bringing Federal resources to bear on solving problems.

We need funding for research on occurrence, treatment and health effects. We need source protection, leak detection, and cleanup. At the Federal level we need your help in encouraging EPA to change directions. We need more flexibility in the way the air quality laws are implemented then enforced, and we are looking very hard at the Bilbray legislation as a potential source for that flexibility.

But I happen to agree with you, Senator, that we need to act sooner than any legislation can pass. That's why I was encouraged to hear you say that you are considering urging Secretary Browner to use her emergency powers. We're usually the ones standing up and saying let's not rush to a decision. In this case there is so much at stake I would hate to see delay that causes a loss of public confidence and millions, if not billions, of dollars being wasted.

One area in particular where we think you can be helpful, Senator, is in assuring that appropriations are adequate to fund the State revolving funds for source water protection and cleanup. It's an area which we think has been overlooked and which we're very interested in, and we—I was heartened to hear Ms. Dougherty talk

about source water protection. We think it's an important element in this puzzle.

Let me close by saying that we in California have a lot of conflicts over water. We don't have any to waste, and if we lose valuable sources of supply the conflicts over water are going to grow that much greater. We need research to treat it and to assure public health, as well as research on occurrence and cleanup. Most important, we need measures to protect against compounds like MTBE getting into our groundwater and surface water. Knowing your commitment to water resources and to public health, we look forward to working with you, and we thank you for taking the lead on this problem.

Senator BOXER. Thank you so much, Mr. Hall, and, as usual, you laid it out for us. You said very clearly, we have to deliver water and the water has to be safe, and the people have to believe it's safe, and MTBE is making it really hard. I think as this—as these panels move forward I'm becoming more and more convinced of the need to do something very quickly.

Mr. HALL. Senator, I know time is short, I don't want to take undue time, but Senator Mountjoy brought you an extreme example of how contaminated water can become. Ours is not as extreme, but I think it points out it doesn't take much to show up in terms of taste and odor.

Senator BOXER. Yes. Please share that with us.

Mr. HALL. We have an odor-free sample, which I'll give to the sergeant. This is our baseline. We have some with 70 parts per billion, and then the level of contamination in Santa Monica is 600 parts per billion. What you'll find—what you should find in the odor-free sample is no odor. You'll probably smell a slight ether type or turpentine type odor in the 70 parts per billion sample. I think it will be unmistakable at 600 parts. It will not smell like something you want to drink. So I'll pass these on to you, Senator.

Senator BOXER. Right.

Mr. HALL. I invite you to smell them but not to drink them.

Senator BOXER. I assure you I will follow your advice. I think we were given a sense of smell for a reason——

Mr. HALL. That's right.

Senator BOXER.——and we're finding it out here today, because no sensible person would drink water that smells that way. Senator Mountjoy, do you have a question for Dr. Spath?

Senator MOUNTJOY. Yes.

Dr. Spath, during the period in time in which my bill was going through the legislature the Italian study by Maltoni was brought up, and that testimony went to the fact that it was peer-reviewed, that, in fact, it did cause cancer in rats when ingested. It was peer-reviewed by nine reviewers. One was the OSHA Assistant Secretary; two scientists that were directors of the National Institute of Environmental Health and Science, part of the NIH; and two scientists from EPA, one was the assistant administrator for research and development of EPA, one was the assistant scientist for EPA; two scientists from NIH and two from the academia department heads. So, our information as the bill proceeded was that that study was peer-reviewed by these folks, some nine different sci-

entists, and the conclusion was, yes, ingestion did, in fact, cause cancer in rats.

Mr. SPATH. I was not aware of that and maybe I could turn to Cynthia Dougherty, because this, as you suggested, Senator, was done at the Federal level.

Ms. DOUGHERTY. The Italian study was in a peer-review journal, so there was a peer review of the article. What the Office of Science and Technology Policy Report suggested, and actually the National Academy of Science peer review of that, the draft of that report, suggested was that more data needed to be available to actually see what was behind the conclusions that the article had. NIH attempted to try to go see—I'm not a scientist, so, I mean, we're getting a little bit beyond my——

Senator MOUNTJOY. Nor am I, but——

Ms. DOUGHERTY. But NIH attempted to go to Italy to see the data behind the article, and attempted to do that several times over the past year and a half, and were not able to successfully do that. So without being able to do that and to see the data that was behind it, and how that data was collected, we're able to say that that article exists and that the conclusions were peer-reviewed, but not able to really use it fully as you might with another kind of study. Our health—our drinking water advisory that we just put out yesterday talks about why—you know, provides that information, but talks about why we think it's not as useful as it could be if we could see the rest of the data.

Senator BOXER. Well, do we know why the NIH couldn't get out? Sounds like they couldn't get on a plane or something. I mean, what's the——

Ms. DOUGHERTY. No. It has more to do with the people in Italy——

Senator BOXER. That they weren't interested in allowing our people to go over the data? Is that it?

Ms. DOUGHERTY. We'd have to talk to NIH about that. But I understand they wouldn't allow it.

Senator BOXER. OK. Well, if we could—if you would help me do that, I'd like to make an inquiry to NIH. But the fact is the article was peer-reviewed; is that correct?

Ms. DOUGHERTY. The article itself was peer-reviewed but not the data behind it.

Senator BOXER. OK. All right. Well, thank you so much, Senator Mountjoy.

Senator MOUNTJOY. I appreciate that.

Senator BOXER. A couple of questions. You know, a couple of times we've heard of a legislative attempt to try and go beyond MTBE to other—to the whole issue of oxygenates, and are all oxygenates in this category? I mean, is ethanol—do we have any of these problems with ethanol leaking at this point? Ethanol is an oxygenate that we use. Dr. Zogorski? Mr. Shulters?

Mr. ZOGORSKI. We don't have any Agency information on ethanol at underground storage tanks, nor are we monitoring for it in our national water quality assessment program.

Senator BOXER. Has ethanol—has it shown up in these water supplies, drinking water supplies at this stage?

Mr. ZOGORSKI. I'm not aware that anyone has reported ethanol in drinking water.

Senator BOXER. Well, that's my question.

Mr. ZOGORSKI. Right.

Ms. DOUGHERTY. It's also used at much lower percentages usewise than——

Senator BOXER. And why is that?

Ms. DOUGHERTY. Just because of the decisions that were made in terms of using MTBE as the oxygenate of choice.

Senator BOXER. OK. Yes.

Mr. ZOGORSKI. Ethanol has less oxygen in the molecule than MTBE.

Senator BOXER. I see. OK. Yes, Secretary?

Mr. ROONEY. And, Senator, there's other forms of ethanol. The ETBE ether form of it, I mean, would be another vector, potentially. TAME is another one of the possible products. We don't know as much, probably, about TAME and the others as we do about MTBE. I think that gets me back to why we were asking for your support in the Bilbray legislation in that if you could remove the oxygenate requirement, then we get away from the issue of just substituting one of these others, the TAME or something else, for MTBE. But if you still require the oxygenate element, then we're stuck with the choice of what other oxygenate.

Senator BOXER. Certainly.

Mr. ROONEY. If we could move forward to getting beyond that——

Senator BOXER. Yes. Yes.

Mr. ROONEY.——our bigger issues would be solved.

Senator BOXER. I think it's a very important point here. To me, I don't think we should allow anything to be added to the water unless we know the answer first as to what it's going to do to humans. I mean, I just think clear across the board it seems like——

[Applause.]

Mr. ROONEY. Well, certainly, and we would agree with you, Senator, the gasoline itself should not be added to water in whatever its form, in its older forms with the benzenes and whatnot. So to the extent that contamination occurs, that is poor public policy, and we do have to do whatever we can to prevent this cross-mixing of our——

Senator BOXER. But, see, but I just think that whatever we do, let's say we do the Bilbray bill, the Bilbray/Feinstein bill, maybe that has some unintended consequences that because we say we do certain things people rush to another solution and that solution turns out not to be right.

See, my concern is that we're beginning to get a lot of information on MTBE. I don't want to divert the conversation away from that to some other issue where the public is confused, we're opening the Clean Air Act, we're amending it in different ways.

Let's handle the MTBE situation here, and then I think the maximum flexibility we can give any State, as long as they meet the air quality without harming the water quality, is—I don't have any philosophical problem with that whatsoever. But I don't want to get us off—I don't want to take my eye off the MTBE ball right here, which is what I'm afraid we're going to get at, because it's

very easy for people to wiggle out of doing anything when the issue gets diffused, if you get my point.

I've had so much experience in government and I think that Mr. Hall's testimony perhaps was, you know, the most direct. I care about what real people worry about, and what real people worry about is they're tasting the stuff in their water and then they call up their agency and say, Is this dangerous? And you know what the agency's going to tell them? Well, there's a peer-reviewed article but it wasn't really—the data wasn't peer-reviewed but the article was peer-reviewed, and that said you could get cancer, but we're really not sure and it's going to take us till 2002 unless there's an emergency, and then the Federal Government could—please. We wonder why people lose faith.

I mean, I think we need to keep our eye on the ball here, and I'm happy to support bills for the long range. I'm happy to support research, but I also think we got to get back to the basic premise. If I can't look someone in the eye and tell him, you know, this stuff is in your water and it's OK, even though it tastes bad, I mean, if I can't do that I don't feel very good about what I'm doing, because I'm supposed to protect the health and safety of the people, as are so many of you around this table.

I don't think we can really feel good if we can't answer that question, which takes me back to that major point, which is, we didn't know what we were doing when we did it in the early 1990's, or the late 1980's, or whenever it was that MTBE started to be added. So, you know, there's some point at which you cut your losses, you admit your human fallibility, you move forward, and it may be we're at that point and, you know, I'm thinking—I'm going to hear one more panel, but I'm getting to that point.

I want to ask EPA this question about the type of health tests that we're doing where we're just isolating MTBE and exposing the animals to it, but we're not exposing the animals to the gasoline, which includes the MTBE, and, so, we're not getting the synergistic impact of it.

Ms. DOUGHERTY. I may have to correct this if I'm misstating it, but my understanding is that a lot of the studies that have been done to date have done that where they've just looked at MTBE in inhalation studies, but that the 211 testing under the Clean Air Act that I talk about in my testimony will look at that other issue, which is if you looked at conventional gasoline versus gasoline with MTBE what kind of effects would you get. So we'll be testing that. It'll be starting. That'll be paid for by the industry under Section 211 of the Clean Air Act——

Senator BOXER. Well, that's good news, because we did not have the information. So they're going to now be testing it when it is, in fact, mixed into the gasoline.

Ms. DOUGHERTY. Yes.

Senator BOXER. I'm not going to go into these issues that I have already commented on because I don't want to put you in a situation of answering the question, why did we put the cart before the horse, because you weren't there and you didn't make that decision. But let me just say, in the case of Santa Monica, which is just probably the tip of the iceberg, but the place that had this problem first and brought it to my attention, are you staying close to the

city and working with them? Because, you know, again, we get to the point where we're saying this was a decision, the Federal law allowed the use of MTBE, no standard put into place, and now they are affected with 70 percent of their wells. So are we assisting them and helping them, and do we intend to stick with them on this problem?

Ms. DOUGHERTY. EPA is assisting the city and, actually, Julie Anderson is here from our regional office and——

Senator BOXER. Julie, could you tell us what you're doing to work with the city?

Ms. ANDERSON. Yes. We're working very aggressively right now to take action against the potential responsible parties to determine who might have actually contributed to the contamination of the underground fields. Right now we feel that it was very important for us to enter that case, although usually those kind of actions are undertaken by our State agencies.

The city of Santa Monica did request that we get involved. Because of the nature of the contamination, of it having had such widespread effects, and the fact that it was a contaminate that we did not have a lot of experience with yet, in terms of developing cleanup standards or developing remediation techniques, the EPA felt it was very important that we step in and had a role to play, in conjunction with our State counterpart. So we are——

Senator BOXER. OK. But I think there's more to it than this, because it seems to me the Federal and State government allowed this to be added, and, you know, the oil companies that stepped forward in—and I'm always—many times on opposite sides of the oil companies when it comes to pollution and offshore oil drilling, but in this case they came forward and they agreed to pay—how much of the costs—75 percent of the costs for a particular well cleanup. But don't you think that there's a responsibility of the Federal Government and the State government that allowed this chemical to be added, to be a party to the solution?

[Applause.]

Ms. ANDERSON. Again, I think we really do have to place responsibility with those who allowed the materials to leak as well. I think it's very important——

Senator BOXER. Yes.

Ms. ANDERSON.——that we look at the distribution and storage systems and make sure that we take all efforts to prevent those kind of leaks down the road, and then to be very aggressive in enforcing, then, when they appear.

Senator BOXER. Yes. Well, I agree that if people had their tanks in bad condition. The situation with MTBE may be that even if they had the tanks in good condition the MTBE has such a corrosive effect, but we—you know, we don't know the answer, but South Lake Tahoe said it may be.

I think before we assign the blame we need to see if, in fact, these are really old tanks. That's one thing, but if they weren't, that's another thing. So it raises a lot of questions. I'm going to be working through my chairman to see if we can get the Federal Government in a posture to take a little bit more responsibility, if you will, than we have up to this point. Because, you know, again,

the buck stops at our door, and certainly at the State's door, you know, and I think we need to stand up to that responsibility.

Well, I want to thank each and every one of you. This is a difficult matter and you've been just very forthright, and I do appreciate it and look forward to working with you.

We're going to take a 10-minute quick break for getting a drink of water or something like that, clean water, and we'll be back in 10 minutes.

[Recess.]

Senator BOXER. We're ready to continue the hearing and complete the hearing, and I'm very happy to say that this panel is the panel on public health, which is very important to everything that I will be taking back to my chairman. We're going to ask if people could close that door, please, and take your seats.

We're going to begin, if he's ready, with Dr. Nachman Brautbar, Professor of Clinical Medicine, University of Southern California, School of Medicine. Thank you so much for being here.

STATEMENT OF DR. NACHMAN BRAUTBAR, PROFESSOR OF CLINICAL MEDICINE, UNIVERSITY OF SOUTHERN CALIFORNIA SCHOOL OF MEDICINE

Dr. BRAUTBAR. Senator Boxer, members, ladies and gentlemen, I'm going to read my statement, in the interests of time. I've provided to the panel a dossier with a little journal.

Senator BOXER. Yes. Thank you, Doctor. We have this book.

Dr. BRAUTBAR. My name is Dr. Brautbar, a medical doctor from Los Angeles, and a 23-year resident and citizen of California. I'm testifying today as a physician and scientist. I have no political agenda and have not received any compensation from either the opponent or proponent.

I practice medicine, treat patients, and teach at the University of Southern California School of Medicine, and hold the title of Professor of Clinical Medicine, and former Associate Professor of Pharmacology. I am a member of the National Society of Toxicology, American College of Toxicology, and others, and have published over 160 scientific papers in medicine, toxicology and pharmacology. My resume is attached to your dossier as Exhibit A.

In the last 5 years I have studied the health effects of MTBE in gasoline on patients, and personally examined over 350 patients with MTBE health-related problems from drinking water contaminated with MTBE and gasoline. Those 350 patients did not know that they were exposed to MTBE and gasoline, developed skin rashes, sinus congestion, headaches, loss of memory, shortness of breath, asthma and diarrhea.

These symptoms started sometime in 1992 and were verified by review of medical records, examination and laboratory testing. Before these patients were exposed none of them experienced any of these symptoms and findings. Removing these patients from MTBE and gasoline contaminated water resulted in improvement and, in some, complete reversal of these pathological and disabling findings.

In addition to the objective studies documenting the validity of those complaints, I have conducted studies of the blood cells in these patients. These tests showed that the life span of the white

blood cell of these patients was reduced significantly, indicating serious harmful effects of MTBE in gasoline, in line with the position of the leading physicians and scientists worldwide that MTBE in gasoline is harmful to humans, as summarized in Exhibit B. My studies have been published in scientific peer-reviewed journals, reprints of which are attached here as exhibits C and D.

MTBE causes cancers in many organs in significant numbers of animals and are identical to doses described for other carcinogens, such as vinyl chloride and benzene at similar doses. My opinion is supported by the general agreement among experts in chemical carcinogens and in the—by the International Agency for Research on Cancer, namely, IARC, that in the absence of adequate data on humans it is biologically plausible and prudent to regard agents for which there is sufficient evidence of carcinogenicity in experimental animals as if they presented a carcinogenic risk to humans. See Exhibit E in my dossier.

The substantial weight of evidence clearly indicates that MTBE is carcinogenic. This is reported by several studies where MTBE was shown to cause cancer in two different types of experimental animals.

By the way, I must state that I personally spent approximately 2 months with Professor Maltoni in his institute in Bologna. There were scientists from Sweden, Belgium, France, Japan and other countries, and his question was: Where is the EPA? Where is the NIH? They wanted to come and visit. I personally have viewed those slides, by the way.

The medical scientists have found it clear that pregnant women, young children, people on medications, and sensitive individuals are at even greater risk for developing cancers and diseases, thus the levels of exposure for these individuals may be extremely high. Cross-sensitivity of MTBE in gasoline is many times around 60 to 100 greater than MTBE alone, and causes a variety of illnesses, including neurological, allergic, and respiratory, and this indicates strong synergistic interaction with other chemicals, as in the case of, for instance, asbestos and smoking. It is this synergistic effect of MTBE in gasoline contaminating the drinking water and consumed by children, pregnant women, elderly patients and patients on medications, which is our concern. This synergistic effect is described and summarized for you in Exhibit F in my dossier.

My office receives phone calls daily from patients who are sick and have been exposed to MTBE and are seeking medical help. This problem is not unique to the citizens of California. Patients in Alaska, Maine, New Jersey, North Carolina, and others, have been presenting with these same problems. Indeed, the State of Alaska has banned the use of MTBE in gasoline as a result. See Exhibit G in my dossier.

Our great State of California, under the leadership of Honorable Senators Mountjoy and Hayden, is following the footsteps of Alaska. Most recently Chevron announced that the company is asking to make gasoline without MTBE, saying, quoting, that, "MTBE and similar chemicals do little to reduce smog and is a threat to water supplies."

I believe that the scientific data and medical studies are clear, concise, and the public, as well as realistic manufacturers such as

Chevron, are recognizing that exposing the public to MTBE in gasoline is dangerous. Thank you.

Senator BOXER. Thank you very much. I want to make sure that our EPA people who were out at the break get a copy of your statement. We have heard a very shocking report and I just want you to have it. For a susceptible individual there may be 100 times greater risk for contracting and dying from cancer.

Next I would ask Dr. Balter, Ph.D., Principal, Center for Environmental Health and Human Toxicology, former Associate Professor Pharmacology at Georgetown, to address us. Welcome, Dr. Balter.

STATEMENT OF NANCY J. BALTER, PRINCIPAL, CENTER FOR ENVIRONMENTAL HEALTH AND HUMAN TOXICOLOGY, AND FORMER ASSOCIATE PROFESSOR OF PHARMACOLOGY, GEORGETOWN UNIVERSITY MEDICAL CENTER

Ms. BALTER. Thank you, Senator Boxer. I appreciate the opportunity to testify before this committee. My curriculum vitae has been submitted with my statement. Briefly, I'm a pharmacologist and toxicologist who's spent most of my professional career on the full-time faculty at Georgetown University School of Medicine.

In 1995 I retired from academics to move to Colorado, where I'm a principal with—new name, same company—International Center for Toxicology and Medicine. I work as a consultant on a variety of environmental and occupational health issues. As a consultant to the Oxygenated Fuels Association since 1993 I am very familiar with the health-related studies of oxygenated gasoline, in general, and MTBE specifically.

I've served as a consultant and peer reviewer for the U.S. EPA, CDC and the National Academy of Science on this issue, and have written a paper on the acute health effects associated with exposure to oxygenated gasoline, which will be published this month in the journal, "Risk Analysis." I have provided the committee with a copy of this manuscript.

I also want to note that I am accompanied today by Mike Cavanaugh, who's in the audience. He has done a number of studies and can address questions you might have related to treatability and costs of remediation.

My testimony deals with the health implications of the continued use of MTBE in gasoline. In addressing this issue I cannot stress enough that the consideration of the potential for toxicity of MTBE must be weighed against the benefits associated with its use in gasoline. The question we need to ask is: How do these risks compare with the health benefits that accrue because the presence of MTBE in gasoline reduces exposure to gasoline-related toxins, including carbon monoxide, ozone, and known human carcinogens such as benzene and 1,3-butadiene?

MTBE is an extensively studied chemical and we know a great about the exposure concentrations necessary to cause toxicity. This dose response, the idea that you have to have a particular exposure before you see an effect, is a principle of toxicology that everyone knows about.

I certainly agree with Senator Hayden when he says that MTBE is a neurotoxin, but at very high levels of exposure, levels of expo-

sure higher than individuals in the general public would ever experience. In fact, in the recently released EPA health advisory they give for water a threshold for neurotoxicity of 7,400,000 parts per billion in water. Although the concentration of MTBE in water contaminated as a result of a gasoline leak or spill can be high, humans are not likely to be exposed at these levels for long because of what we've all been talking about, the effects of MTBE on taste and smell characteristics of the water, making the exposure self-limiting.

In situations where there has been a significant gasoline leak or spill and MTBE concentrations are high, there might be short-term exposures that result in irritant effects. However, longer exposures at these levels are not likely to occur because of the taste and smell characteristics of the water. Although there are no animal studies involving long-term drinking water exposure, the threshold for toxicity can be extrapolated from studies involving other routes of exposure. Doing this, it is clear that humans will not be chronically exposed to MTBE in water at concentrations associated with chronic toxicity.

MTBE causes several types of tumors in animals exposed to high concentrations of the chemical. While it is generally assumed that a chemical that causes cancer in experimental animals poses some risk of cancer in humans, which is the statement that Dr. Brautbar made, there are exceptions to this conservative assumption, depending upon how the chemical acts. MTBE could be one of these exceptions and an additional study is taking place to determine whether it is or not.

For the purposes of this discussion, though, I'd like to assume that MTBE, based on what it does in animals, does pose a carcinogenic risk to humans. Now the question is: How does the potential increased cancer risk associated with MTBE exposure in air, plus in water, compare with the decreased cancer risk that accrues because of MTBE's effect in reducing exposure to known and potential human carcinogens in gasoline?

I'm going to use numbers that were presented in the September 1997 CAL-EPA briefing paper on MTBE for the airborne part of the calculation. The calculated increase in risk associated with breathing MTBE as a result of its use in gasoline is one to two lifetime cancer cases per million people exposed. Balance against this is a decreased risk of about 60 per million that occurs because the use of the reformulated gasoline reduces the opportunity for gasoline associated exposure to known human carcinogens, such as benzene and 1,3-butadiene. I want to stress we're talking about things we know cause cancer versus MTBE, where we're going to assume that it causes cancer.

Senator BOXER. Can you finish in 2 minutes, please?

Ms. BALTER. Absolutely. Now we have to deal with the exposure from water, and in doing these calculations I am using the data from Maltoni, in spite of the fact that EPA and many other people have suggested we not do that until it has been reviewed.

Lifetime exposure to MTBE at the upper level of consumer acceptability increases cancer risk by five per million, so that the total MTBE associated risk from air plus water is six to seven per million compared to a decreased cancer risk of sixty per million.

Lifetime exposure to MTBE in water would have to occur at a concentration in excess of 500 parts per billion before the net calculated benefit of MTBE is lost.

The scientific and regulatory communities will continue to study MTBE and some questions do remain. While the toxicity of MTBE is well studied, as you have pointed out, we need to look at gasoline with and without MTBE in it and compare those. Those studies are planned, will be getting underway shortly, if they haven't already.

Another question has to do with sensitive populations. Nothing in the toxicologic profile of MTBE would suggest that there are sensitive populations, but at least one study which does involve exposure to a gasoline type mixture with and without MTBE is currently underway.

Another question, which I won't go into in detail, has to do with do we need to do animal studies where animals are exposed to MTBE in drinking water. There are actually techniques to model going from an inhalation exposure to a drinking water exposure. Two models have been developed. They are currently being validated. I think from my reading of the EPA's health advisory they're waiting for those models in order to have the confidence they want to have in developing a health standard, although, as you heard today——

Senator BOXER. OK, we have to finish.

Ms. BALTER. Yes. As you heard today, the—what they have suggested will protect against health.

Continued examination and confirmation of the benefits and risks associated with the use of MTBE in gasoline is appropriate, but there are adequate data at this point to support the safety and benefits of the continued use of MTBE containing reformulated gasoline, as these studies are being done. Thank you.

Senator BOXER. Thank you.

Gary Patton, it is just a pleasure to welcome you, and, of course, I followed your career from all levels of government and I'm just very happy to see you here today representing The Planning and Conservation League.

STATEMENT OF GARY PATTON, ESQUIRE, COUNSEL, THE PLANNING AND CONSERVATION LEAGUE

Mr. PATTON. Well, Senator, thank you very much.

My name is Gary Patton. I have submitted written testimony and I am very delighted to have been invited to testify before you, but more than being delighted to be here to testify, I am delighted that you are providing leadership on this issue in a situation in which, I think regrettably in this case, California is once again leading the nation.

Air pollution's everywhere in the nation. California has more. Actually, MTBE in reformulated gas, I believe, is used almost throughout all of the States, but California has a new version in which, essentially, 11 percent of the volume of gasoline is MTBE, and we have some problems associated with that. It is critically important, as Senator Hayden said, and let me say it again, that you're taking the leadership position you're taking. So thank you.

Now, as you look into this, remember that California, in leading the nation into MTBE, made the single most significant improve-

ment in air quality since the catalytic converter by doing that. Fifteen percent, I think, is the number that we accept in terms of basic criteria pollutant reductions associated with the use of reformulated gas, the Phase 2 cleaner burning fuel in California. I can't, on a panel that's talking about health, overemphasize that there are incredibly important health benefits associated with reducing air pollution, and that is critically important as we study this issue.

However, Senator Hayden said again, and I think you have, in your questions, pointed this out, there was a mistake in governance in the way MTBE was introduced, and I think that, in fact, almost everybody will admit that. The mistake was it was just assumed, but never tested, that MTBE was going to be like any of the other constituents of gasoline, and it turns out in groundwater and in soil it reacts differently. It is a different animal, and wouldn't it have been wonderful if we'd have tested this and known what was going to happen ahead of time? We now are doing that in California, Senator Mountjoy's bill chaptered into law. The bills that both Senator Hayden and Assembly Member Kuehl carried are having California now investigate, I think in a fair way, what are the burdens and benefits, and the risks and benefits of MTBE. In about 14 or 15 months the Governor of the State, whoever that person is at that time, is going to have to make a decision, based on a comprehensive health study, that on balance there is or there is not a significant risk to human health or the environment of using MTBE in this State. So we're going to decide this. Maybe in 15, 16 months something is going to be done.

You're suggesting maybe we should be doing something sooner, and I would like to suggest some things that you, as a senator, could do and should be thinking of, some of which you've already alluded to. One of them, though, is going back to the air quality gains. Would you please try to work, in Washington, in the statutory measures that are before the Congress, and that may be put before the Congress, and in your work with the EPA, that whatever is done to cure the problems with MTBE contamination in groundwater we don't tradeoff the incredibly important air quality improvements that have been made because of the use of reformulated gas? We do need to both protect air quality and improve air quality, and protect our groundwater quality. So please maintain that commitment to air.

Second, I think that we do need to begin trying to have other alternatives available, because if the Governor makes the statement in 18—in 16 months that there is a possible risk to the use of MTBE we're going to have to have some other alternatives. I think the alternative of ethanol, which has some possibly adverse impacts in certain parts of air emissions, does need to be studied thoughtfully. I think the EPA can help our State work on alternatives, and you can, just in a collegial way, make that happen, and I urge you to do that.

I do think we need to strengthen and improve the systems of Federal and State law relating to underground tanks and underground pipelines, and pipelines in general. I would specifically urge you, however, not to assume that double-lined tanks, like the double-lined hulled tankers that for offshore oil don't work—I don't

think it's the double-walled tanks that are failing. I think that what is failing is the piping systems which are under pressure, the seals and so forth, and I don't think that that's been examined, and I hope you will stimulate some examination of that.

It may be we need to move, when we have underground tanks with MTBE or any other compounds, to systems very much like in landfills that collect leachate and do not let things escape to the groundwater, because as you so correctly pointed out, California doesn't have any water it can waste.

And, finally, I want to—no, not finally. Cleanup assistance you have delivered for this State time and again, as others have said. Thank you for doing that. We're going to need your support on Federal resources on cleanup for the problem that has been created, partly with government acquiescence, but also, let's say, at the prodding of the oil companies. They're certainly not immune from this particular problem, having caused it.

The larger perspective is what I'd like to end with. Again, it's come up before. We have solved many of our environmental economic problems in this country, as you know, because you've provided this leadership from the time we were both on boards as supervisors, by finding ways to be more efficient with the resources we use.

Energy, we don't have to build lots of nuclear plants. We can do it efficiently. Water, water conservation is a way, and the Cal Fed process is going to produce something, we hope, that will be able to be a win-win for all involved, but using water efficiently. Let's use fuel efficiently. Let's use our transportation system efficiently. We have fuel efficiency standards at the Federal level that are much less than is what is clearly attainable with current technologies. Please continue to fight for those. We have air quality standards for cars which are very, very good, but not for light duty trucks and not for heavy duty trucks. Let's get everybody under the program and eliminate the need for some of these other techniques.

And, finally, let's remember that we—you know, the oil companies right now, and the ARB, are publishing advertisements bragging about how we've been able to clean air, or make progress on cleaning the air, even while we're escalating the number of vehicles and the miles we're driving. Well, that's true, we are making a little progress, but wouldn't we be making wonderful progress—in fact, we'd have solved the problem if we could find ways to make our transportation use more efficient, transit, rail, and sharing rides.

When you go to the Los Angeles Airport and get out you get in a little shuttle system. It goes wherever you want to go. Why can't that be a computer system for everybody so that most in trips in urban areas are really carried in the kind of shuttle systems that work in Asian and European nations? We can do it in California, even having built our infrastructure for the automobile. We need to do it.

It's an investment the Federal Government can stimulate, as you've already indicated in your questions and your comments, and we need to make that investment, because, in fact, it isn't a question of how much we're going to have to spend, it's how much we're

going to have to save, because we actually save money when we do things more efficiently.

That is my testimony. I again want to thank you for your leadership on the issue, because somebody asked me at the break: Is something significant going on here? They had just come in. I said, I think something significant is going on here. We, as a body politic, are making a decision about how to deal with a problem that we caused because we didn't, in the first place, look at a multimedia approach. You can work with the EPA to make certain that never happens again. Any time anything is being introduced into our environment where it can go in the air, in the water, and the land, we need to know it's safety first.

Senator BOXER. Absolutely.

Mr. PATTON. Thank you so much.

Senator BOXER. Absolutely. Thank you, Gary Patton. I mean, that is clearly something we have to learn from this, because there's going to people come to the table and say, Well, don't worry about it, you know, it's really—like Dr. Balter, who's giving us her opinion. She works for the Oxygenated Fuels Association, since 1993, and they have a point of view and she shares it, and she feels, you know, from her testimony, that, you know, status quo is fine, and——

Ms. BALTER. I don't think that was exactly what I said.

Senator BOXER. Well, let me just say I heard you say that you could ingest MTBE up to 500 parts per billion even under the worst circumstances and have no ill effects. Is that correct?

Ms. BALTER. No. No. Oh, no, no, no, no, no. I was dealing with——

Senator BOXER. I wrote that down. That's what you said.

Ms. BALTER. I was——

Senator BOXER. And you said even using the Italian doctor's work.

Ms. BALTER. And I was talking about cancer risk——

Senator BOXER. Yes.

Ms. BALTER.——and I was talking about the equation. If you add the cancer risk from drinking water, from inhaling it in air, and balance that against the decreased cancer risk, that only after you exceeded 500 parts per billion over the course of a lifetime would you lose the net benefit in terms of cancer risks.

Senator BOXER. No, I understand, but the——

Ms. BALTER. That's what I was talking about.

Senator BOXER.——result of that statement, Doctor, is that, don't worry about it because—let me finish my point. That's the result of the statement, because who's going to get 500 parts per billion over a lifetime? They're not going to allow it to happen because they can taste it at five parts per billion, your point exactly. So what I'm saying is your opinion is it's OK, and I think that's the fair analysis of your statement. You're not recommending that we phase it out. You're not recommending that we move to another oxygenate. You're not recommending any specific steps be taken.

Now we have Dr. Brautbar, on the other hand, who comes to us, who is telling us that this is a dangerous substance, and then we have Gary Patton, who was making some very intelligent statements about the larger picture, and also saying, Keep in mind the

benefits and the risks, Barbara, as you go into this. I think that's an important cautionary word.

But, you know, when you have two health experts come to you and they have such different views I think it's kind of interesting to let them talk to each other a little bit. So in the next five or 6 minutes I'm going to do something really different, which is lose control of this for five or 6 minutes. I'm going to ask Dr. Brautbar to ask Dr. Balter a question, and if they can move it along, and ask Dr.—because the thing is, you are coming from two different places and the public could get confused.

Dr. Brautbar, you have heard Dr. Balter say that—you know, exactly what she said, and she takes a very opposite view. You have told us that MTBE present in the drinking water is an absolute problem, it will cause cancer, is a danger. Could you ask her a question of why she believes what she believes?

Dr. BRAUTBAR. OK. You are aware that the regulatory level of benzene in the drinking water is 1 ppb in the State of California, .7 to 1 ppb?

Ms. BALTER. It varies from——

Dr. BRAUTBAR. Well, let's accept it as a fact.

Ms. BALTER. Fine. OK.

Dr. BRAUTBAR. OK? And benzene is a carcinogen. Right?

Ms. BALTER. Benzene is a known human carcinogen.

Dr. BRAUTBAR. That's right. So you're talking about a carcinogen which is taken down to as low as .7. Realistically, I would like to see zero, but practically, you're talking about .7 ppb. Now, you're suggesting that MTBE, which is by definition of the International Agency of Research on Cancer, is a carcinogen, not known, but possible or probable, depends on who you read, and you suggest that it's OK to let it go up to more than 1 ppb?

Ms. BALTER. First of all, you can't equate MTBE and benzene.

Dr. BRAUTBAR. Why? It's a carcinogen.

Ms. BALTER. Benzene is a known——

Dr. BRAUTBAR. Carcinogen.

Ms. BALTER. Did you ask me a question and did you want to hear the answer?

Dr. BRAUTBAR. That's fine.

Senator BOXER. Well, wait a minute, I'll—I'm going to interfere.

Dr. BRAUTBAR. That's fine.

Senator BOXER. Let her answer the question.

Dr. BRAUTBAR. Right.

Senator BOXER. You can't compare the two because?

Ms. BALTER. Because benzene we know—not we think or we assume—we know causes cancer in human beings. There are epidemiologic studies that establish that. We don't have the benefit of epidemiologic studies for many, many, many chemicals, including MTBE. Therefore, we use animal studies, and we will conservatively—it used to be, when I began doing toxicology, if something causes cancer in animals it was assumed to cause cancer in humans, period, the end. We still treated it differently than something like benzene, where we knew it caused cancer in humans, but we made that assumption. Things have changed over the last 10 years as we know more about how chemicals cause cancer, and this assumption is not automatic. I——

Senator BOXER. OK. All right. I'm going to cut you off on your answer because I get what you're saying.

Ms. BALTER. OK. But——

Senator BOXER. But I guess I have a followup, which is this: Would you admit that we don't know—we don't know for MTBE what level causes cancer, if it causes cancer? Would you admit to that?

Ms. BALTER. Well, I would——

Senator BOXER. Yes or no? Do we know? Can you look someone in the eye——

Ms. BALTER. You asked me two——

Senator BOXER. Well, why don't you answer it yes or no? Do we know at this point if MTBE, when ingested in the water at a specific level, causes cancer? Do we know that?

Ms. BALTER. We don't know for sure. I'm willing to assume that it does and that's what I did in my statement. It is not unreasonable to assume that it does. There's a debate——

Senator BOXER. OK. So, therefore, why would you——

Ms. BALTER.——but it's not——

Senator BOXER. Why would you not then support Dr. Brautbar's contention that if we said one part per billion for benzene we should do that until we know for sure for MTBE? Just sort of a common sense approach to it.

Ms. BALTER. Well, it is not an approach that has been taken. There are at least hundreds of——

Senator BOXER. Well, it hasn't been taken, exactly. There's no standard for MTBE.

Ms. BALTER. There are at least hundreds of chemicals for which we have animal data that they're carcinogenic and no human data, and we make the assumption. Those are regulated in a different way, based on dose response.

Senator BOXER. OK.

Ms. BALTER. Based on the concentrations associated with cancer.

Senator BOXER. OK. Dr. Brautbar, one more followup. Then, Dr. Balter, you get to ask Dr. Brautbar.

Dr. BRAUTBAR. I don't know, maybe we're coming from different schools, but the most current text of toxicology and the most current papers of toxicology clearly state that there are carcinogens and many of those don't have dose response. You don't have dose response in carcinogenesis. You have dose response in toxicological effects, but not carcinogenesis. Benzene, specifically, is a known dose response carcinogen. I don't know where you're taking that idea that carcinogens have to have dose response.

Senator BOXER. You want to respond, and then ask him a question? And welcome to Crossfire.

Ms. BALTER. I didn't know that.

Senator BOXER. OK. No, go ahead. I'm finding this very—it's very useful for me, so go ahead.

Ms. BALTER. We're having a semantic disagreement. Carcinogens have dose response. It is assumed that there is not a threshold when you're dealing with a carcinogen. It's a conservative assumption, but you assume that whereas if you're talking about neurotoxicity there has to be a certain exposure before you have any increased risk in neurotoxicity. For carcinogens we assume

that there's no threshold, that any exposure causes some incremental increase in risk. There is still a dose response relationship, which means the higher the exposure the greater the probability of the effect. That's what dose response is, and it's true for carcinogens as well as noncarcinogens.

Senator BOXER. Do you want to ask Dr. Brautbar a question?

Ms. BALTER. The problem—the main problem that I had with the testimony you gave is its focus on MTBE. I——

Senator BOXER. Well, that was the purpose of the hearing.

Ms. BALTER. We are exposed to MTBE as a component of gasoline, and the question is: In your opinion, given what we know, what we've heard, what Mr. Patton just talked about, about the air quality benefits, the California estimates of the decrease in, for example, benzene exposure, known human carcinogen, where in your analysis did you do the risk benefit, did you come to the conclusion that MTBE is so terrible and so potent that its use in gasoline outweighs its benefits?

Dr. BRAUTBAR. Well, first of all, I think you misstated my testimony. In my writings I talk all the time about MTBE in gasoline, and that is exactly the synergistic effect that you have between two carcinogens, the MTBE and benzene, and it's not one additive to another, as you know, but you are multiplying the risk anywhere from 40, 60, 80 to 100 times. You look at other carcinogens, like asbestos, chromium, nickel, smoking, and others. So that's No. 1. So I'm talking about MTBE in gasoline.

OK. No. 2, you show me the studies that are accepted by oil companies, especially by the one which came here last week and said that MTBE is not doing much to the environment, you show me the studies that have calculated that benzene has been significantly reduced and has reduced X amount of cancers per 100,000 people. I haven't seen those studies in any of the presentations.

Senator BOXER. OK. Well, you know, I come from the school of thought best described by Gary Patton at the beginning, which is before you do something know what the heck you're doing, and then I think——

[Applause.]

Senator BOXER. No, let's—no, no, we don't—and that goes for every one of us, in our personal lives, in our family lives, in our professional lives. If we're giving advice to people, think it through, et cetera, et cetera. Now, particularly when it comes to the health and safety, it seems an outrage that moves were made without knowing what this chemical does.

Now, I don't want to chalk it up to any particular motivation because I really wouldn't know what the motivation was. Senator Hayden talked about decisions being made in back rooms, and I'm sure he's looked at this and I have to say, I'm not about to cast dispersion on any group or anyone, but I know what my responsibility is. You know, if I woke up yesterday and found this out I can't close my eyes to it.

I also happen to know that when you expose children to these chemicals they have a different reaction. Children are not little adults. I am a little adult. I'm only four 11 and three-quarters. But children's bodies are changing, they're growing, they're more susceptible for these things. They're smaller and, therefore, when they

breathe in or drink it's a greater proportion of their body weight. That's why I was very proud to write the Children's Environmental Protection Act, get the support of Carol Browner for that Act. Here we are talking about the impacts, you know, even on healthy people. Imagine the impacts on children who rely on us to protect them.

Now, I have—you know, I'm very glad Dr. Balter came here today to give her opinion, and I don't question that she has any doubt in what she said, but it's the classic case, you know, of the people who are pushing a certain chemical to come in here with doctors and say not a problem. Even if we assume it is a problem, in the end it's not a problem. You know, there's a school of thought, which Dr. Balter I think represents very well.

I'm not a doctor, but I am someone who's in a leadership position, and when people are telling me, no, we haven't done the tests, and we don't know what the problem is, it says to me that that's not good enough. So I think we need to take a time out here. We have enough information in terms of the problem spreading across the country, into other water supplies, and we need to act. We can't wait until we have this kind of problem. We certainly know we have to fix the leaking tanks, and I think even Senator Mountjoy said, very clearly, that even without MTBE we've got a problem with leaking tanks, so we need to fix it. But we don't know, and there's mixed testimony as to whether or not even if we had perfectly beautiful tanks, that MTBE might not corrode through those tanks. We don't know that yet.

I will tell you right now, we're going to get new tanks, and we're going to put the same reformulated gasoline in there. Small businesses are going to invest big bucks and borrow money, and because there's a tough law out there that I support that says they have to do it. But if we sit back and just say, you know, not a problem, and we really don't know, I think we ought to be held responsible.

I am coming to the point where I'm about to make a decision on my advice and request to Administrator Browner, and that's not to say Administrator Browner's going to listen to my advice. She'll listen. Whether she follows it is certainly up to her, and I have a lot of confidence in her. But I think we've got to stop the problem right now and stop adding to it, you know, get your arms around the problem.

[Applause.]

Senator BOXER. Get your arms around the problem, contain it, just as you would in a family. If there was somebody acting out and was destroying the family, you try to contain the problem and then you work on every member of the family. This is a problem that's spreading, literally physically spreading, and we have to stop it.

I don't want to see us go to court, you know, for 3, 4, 5, 6, 7, 8, 9, 10, 11 years, fighting about who's the responsible party. We know the responsible parties, and every one of us in government has to take responsibility, because we didn't even have a standard for MTBE. We still don't have a standard.

Now it's interesting, Dr. Balter, to note that even though you clearly don't act as if you think we need a standard, EPA has given

us an advisory. So they must have a little different view if they're now going it should be maximum 40 parts per billion.

EPA Administrator can use her emergency authority under the Clean Air Act to curb the use of MTBE in order to protect the public health and welfare. I really think she ought to consider doing just that now, because by the time you get into, you know, waiting for another study, finding out if MTBE corrodes the tanks, what is the safe level, there's going to be a huge fight about that, because some people feel there's no safe level. Other people feel if you weigh the benefits against other things it's beneficial. So it's going to take us a long time.

But in the meantime people are telling my friend, Mr. Hall: Don't give me this water because I don't like the smell and I'm not going to drink it, and I'm not going to have it, and I don't care what a doctor may tell me, that I'm safe, because I'm safe even though I'm tasting gasoline in my water, it's perfectly safe because I'm not breathing something else. It isn't going to fly. You know, people aren't going to accept that, and they shouldn't accept it. God gave us a sense of smell and we, you know, are warned, and we're not going to drink the water that tastes so foul and smells so foul.

I just came into this hearing with a range of options on my mind. Certainly, the bigger picture is how do you get away from the use of fossil fuel. We import 50 percent of the fuel that we use. It's a cause of our trade deficit. It's a whole other problem.

Gary's right on the standards for light trucks. I mean, we're falling behind, and those are terribly difficult political fights that are in a different context, but it doesn't mean that we can't pay attention to this one, because this one is an immediate problem.

I want to say that until I can look my constituents in the eye and tell them this is safe, I'm going to work to stop the spread of MTBE, and that's what I've gotten out of this terrific hearing today.

I know it wasn't the easiest hearing to have, you know, Dr. Balter, you put up with some measure of abuse. Dr. Brautbar, you dished it out and took a little yourself. To all the people who came forward, I just want to thank you so much. When I'm home in California I marvel at the strength and the intelligence of our people, and the fact that they are on the cutting edge of all these issues, and this was no different.

Thank you all in the audience who came. I know I kind of tried to keep you from applauding, but you can applaud now. Thank you very much. We're adjourned.

[Whereupon, at 11:46 a.m., the committee was adjourned, to reconvene at the call of the Chair.]

[Additional statements submitted for the record follow:]

STATEMENT OF CALIFORNIA STATE SENATOR TOM HAYDEN, LOS ANGELES, CALIFORNIA

The purpose of this hearing is to examine the impact of MTBE on our water supply which led to passage of Senate legislation this year. My bill (SB 1189) established a $5 million cleanup fund to help local communities while they go after responsible private parties, and requires official health taste and odor standards to be established during the next 12 months.

The scientific evidence points to MTBE as both a carcinogen and a neurotoxin. On its carcinogenicity, I am submitting a paper by Dr. John Froines, chairman of the UCLA Department of Health Sciences. He describes MTBE as a "B2 probable

carcinogen" based on a review of its structure activity, genotoxicity, case studies, epidemiology and animal studies. Based on carcinogenic effects in animal studies, he cites the Health Effects Institute report on oxygenates in gasoline, as follows:

> "In assessing the overall significance of the cumulative data produced by the studies investigating MTBE and TBA in rodents, the most disconcerting aspect of the findings is that the two chemicals produce tumors at five different organ sites in two strains of two species. Considering that the mechanisms of action of these and other non-mutagenic rodent carcinogens are poorly understood, it would seem imprudent to dismiss these results as irrelevant to the human condition."

Dr. Froines calls for urgent further study "while doing everything we can to limit exposure to MTBE."

As to neurotoxicity, I am submitting testimony by Dr. Jorge Mancillas, formerly with UCLA and now a member of my Senate staff. He notes that in 1988, the Interagency Testing Committee (ITC) gave MTBE an "A" designation, which means there is "an unreasonable risk of neuroxicity for which there is substantial human exposure." Animal inhalation studies have shown MTBE's neurotoxic effects, specifically a depression of central nervous system activity. Dr. Mancillas goes into detail about the scientific controversies, concluding that "original studies indicating neurotoxic effects of MTBE have been misrepresented or ignored" by public agencies. For example, the Cal EPA claim in April 1997 that they were "unable to associate them (complaints) with MTBE exposure" was strongly objected to by the authors of those same studies.

More research is always helpful, but what should be condemned without reservation is the lack of conclusive evidence that MTBE was safe before it was introduced in California. Now our groundwater is at risk and the public rightly should be concerned with having to play the experimental role of guinea pigs.

The original point of my SB 1189 and Senator Mountjoy's SB 521 was to place the burden of proof on the State and industry to, show by a reasonable deadline, that MTBE was safe for the public or else phase it out.

That legislative intent was weakened during the legislative struggle. But the final passage of SB 1189 and SB 521 seem to have contributed to a basic rethinking by industry of the prudence of continuing to rely on MTBE.

Chevron and Tosco have made business decisions to consider alternatives to MTBE before waiting for further evidence or public outcry over its impact on groundwater.

In the meantime, we have a lot of groundwater to clean up. A Lawrence Livermore survey says there may be 9,000 gas storage tanks in California where MTBE is leaking into groundwater.

We need double-walled storage tanks in this State and nation as soon as possible. But even that will not work to prevent airborne MTBE contamination of the soil and MTBE pollution of our lakes and reservoirs.

MTBE may not have a future at all. I believe that it is an unacceptable public health problem. Its future depends on the willingness of public officials to reconsider past judgments as well as the internal cost-benefit analysis of the oil industry.

How did this terrible situation arise? It is a question of governance and politics, not simply one of faulty science. I have two comments here:

First, we in the legislature made an historic mistake in delegating to the Air Resources Board the issue of whether and which oxygenates to use in gasoline. This delegation was meant to "take the politics out" of the decision-making process, but in fact the politics simply went behind closed-doors into the dim lit world of professional lobbyists and their scientific mercenaries. We in the legislature now must take steps to reclaim the issue and provide a credible public process to examine the alternatives.

Second, environmental organizations were blinded by a specialization between "air" and "land" experts that split air quality considerations from groundwater ones. As a result, many environmentalists joined in coalition with the oil industry to achieve the standards of the Clean Air Act, not realizing the adverse groundwater impacts nor becoming concerned that some in the industry had created a profitable subsidiary to produce and market MTBE.

So it is time to return to the origins of this debate: how the oil and automobile industries can become compatible with protecting our air and our water supplies.

All over California we hear paid commercials proclaiming that "success is in the air." Why is the public being presented with this propaganda barrage? Why was $13 million just spent by industry to cast doubt on whether global warming is a real issue? Why has our government retreated from a commitment to tougher fuel efficiency standards and low-emission, zero-emission vehicles?

We are driving backwards from our environmental goals. It is projected that our nation's gasoline use is projected to increase by 33 percent in the next 12 years. Every gallon burned emits 2 pounds of carbon dioxide. Industry executives are reveling in our consumption of sport utility vehicles which, according to the New York Times, "will be the fastest-growing source of global warming gases in the United States over the next decade" and which are exempt from gas-guzzler and luxury vehicle taxes. At this rate we will never reach the Clinton Administration's already modest goal of reducing carbon emissions to 1990 levels by 2010. Reformulated gasoline is not the answer, it is only a transitional stop as we look for alternatives to greater dependence on fossil fuels.

Your hearing takes place at an important moment of reappraisal of MTBE, but also at an important global moment when the nations of the world are gathered in Kyoto to discuss global warming. The pollution of our democratic process is the challenge we must address in order to ensure a safe and sustainable resource base for the future. I urge you to take the lead in returning this country to a path of clean and efficient fuels and renewable energy resources.

STATEMENT OF DR. JOHN R. FROINES, SENATE NATURAL RESOURCES ENVIRONMENTAL QUALITY COMMITTEE, MAY 12, 1997

I appreciate the opportunity to appear before you and testify on the matter of methyl tertiary butyl ether (MTBE), the gasoline additive designed to reduce carbon monoxide and toxic air contaminants in reformulated gasoline. My name is John R. Froines. I am Professor of Toxicology and Chair of the Department of Environmental Health Sciences at the UCLA School of Public Health. I direct the UCLA Center for Occupational and Environmental Health.

I serve on two State committees with direct relevance to this testimony: the Carcinogen Identification Committee of the CAL/EPA Science Advisory Board and the Scientific Review Panel of the Air Resources Board. My own research focuses in part on mechanistic issues in chemical carcinogenesis and, in particular, on the carcinogenicity of arsenic and chromium. I co-direct the UCLA Pollution Prevention Education and Research Center, and pollution prevention is directly relevant to the issues before us today.

At the outset I want to list my conclusions relating to the use of MTBE as a fuel additive in California. I will then discuss some of the issues in greater detail.

1. It is highly laudable for the legislature to be holding hearings to determine whether there are problems in the use of MTBE. Unfortunately, MTBE has been used in the United States since 1979 and there should have adequate discussion at the Federal level of the possible risks associated with exposure to MTBE long before we reached the current widespread use of the chemical. In my view the California legislature should establish legislation which requires a thorough review of the possible impact on public health from the introduction of new chemicals with potential for widespread use and possible exposure.

2. The use of MTBE is very wide and growing and becoming international. There were 27 companies producing 9.1 million pounds of MTBE in 1992 and 12. 3 billion pounds were produced in the United States in 1995. The widespread use affects the content of the debate since both government and industry now have a vested interest in the continued use of the product, thereby making an independent, scientifically neutral evaluation more difficult. This reemphasizes why we have to adequately assess chemicals for toxicity before their introduction.

3. While I would prefer us to be discussing electric vehicles or alternative (nonpetroleum) fuels, the issue before us is the use of MTBE in reformulated gasoline. I consider reformulated gasoline to be a major advance in reducing ambient concentrations of toxic air contaminants. I support the use of reformulated gasoline while other alternatives are being developed. Reformulated gasoline has reduced the atmospheric concentrations of human carcinogens such as 1,3-butadiene and benzene.

4. The primary issue to consider here is whether MTBE should be the compound in reformulated fuel used for octane enhancement and reduction of carbon monoxide in the ambient environment? A corollary to that question is whether MTBE has been adequately tested for toxicity. The answer to this latter question is an unequivocal no, and this means the answer to the primary question is uncertain.

MTBE may turn out to be safe with little toxicity but we do not know that yet. The unanswered questions remain before us, and there is considerable uncertainty in the scientific information available to address issues of public health.

I hope that MTBE turns out to be perfectly safe; I have no prejudices about this issue. My concern is that we resolve the uncertainties before we proceed to impact the environment further.

5. Should there be a moratorium on the use of MTBE during the evaluation of exposure, toxicity and other unanswered questions? With our current state of knowledge my answer is an equally unequivocal no. We don't want to increase the concentrations of butadiene and benzene by not using reformulated gasoline with MTBE, but we also should do everything we can to limit exposure to MTBE while unresolved issues of toxicity are being addressed.

6. Are the chronic animal bioassays that have been conducted to determine whether MTBE is a carcinogen relevant to humans or are they specific to the species tested, namely rats and mice? I consider the animal bioassays to be highly relevant and I agree with the sentiments of the Health Effects Institute (HEI) report on oxygenates added to gasoline which concluded:

> "The mechanisms by which exposure to high concentrations of MTBE or TBA [(tertiary butyl alcohol) a metabolite and breakdown product of MTBE] causes tumor formation in different organ systems of mice and rats are not understood . . . In assessing the overall significance of the cumulative data produced by the studies investigating MTBE and TBA in rodents, the most disconcerting aspect of the findings is that the two chemicals produce tumors at five different organ sites in two strains of two species. Considering that the mechanisms of action of these and other non-mutagenic rodent carcinogens are poorly understood, it would seem imprudent to dismiss these results as irrelevant to the human condition."

7. What should we do to evaluate MTBE and how long will it take? In terms of chemical testing for toxicity, I believe there should be collaboration between scientists at the University of California, the Office of Environmental Health Hazard Assessment (OEHHA) and the National Institute of Environmental Health Sciences (NIEHS) to develop protocols to test MTBE. The units within the University of California should be those established by the University and the legislature to address issues of chemical toxicity, namely, the Centers for Occupational and Environmental Health and the Toxic Substances Research and Teaching Program with input from other appropriate faculty.

8. Additional chronic animal bioassays may be required and they can take a considerable period of time. Determination if the use of genetically altered rodents (transgenics) could be used to limit the time would be a matter for consideration. However, the protocols developed for testing should be reviewed by committees with input from affected parties, because if transgenic mice were used, interested parties could challenge the results arguing the test animals were genetically altered and therefore not relevant to the human condition. The requirement for an agreed upon protocol is necessary before any toxicity testing is initiated.

MTBE Background

MTBE is a colorless organic ether used primarily as an octane booster in reformulated gasoline. It has a high vapor pressure. MTBE has high solubility in water; it is mobile and relatively resistant to biodegradation which creates the potential for chronic contamination of groundwater and surface water. MTBE travels through soil quickly and persists in the environment for long periods of time.

MTBE has significant taste and odor problems associated with its contamination of drinking water. The aroma has been reported to be similar to paint thinner or turpentine and can be detected as low as 13.5 to 45.4 ppb, lower than the levels considered unacceptable for health reasons.

Exposure to the public occurs via inhalation where MTBE arises from manufacture of the product, gasoline production, tailpipe emissions and evaporative emissions. Exposure can also occur from contaminated drinking water as we have seen in Santa Monica where levels have been reported as high as 610 ppb.

Carcinogenicity of MTBE

In this testimony I shall address the qualitative issue of whether MTBE should be considered a carcinogen and the level of evidence associated with the determination. I shall not consider quantitative risk assessment since I believe the qualitative issue remains fundamental to its use. I do not believe the issue should be whether to use oxygenated fuel with MTBE as the octane enhancer versus the use of non-reformulated gasoline containing other carcinogenic chemicals. I believe we should be conducting research to identify safe alternatives even while we investigate the toxicity and carcinogenicity of MTBE.

There are five approaches to the identification of a chemical as a carcinogen and more recently the use of mechanistic considerations to assess the relevance of some of these approaches has become important. The five sources of information are:

1. Structure-activity (Does the chemical structure suggest the chemical may be carcinogenic).
2. Genotoxicity (Does the chemical produce alterations in the genetic makeup of test systems)
3. Chronic animal bioassays
4. Epidemiologic evidence (human studies)
5. Case reports

All of these approaches have proved valuable as tools to determine the potential carcinogenicity of a particular compound. For example, vinyl chloride was first considered carcinogenic based on identification of workers with a rare liver cancer, angiosarcoma, at BF Goodrich in the early 1970's. Structure-activity considerations have proved valuable in predicting the carcinogenicity of compounds or their metabolites known to be electrophilic. The Ames assay for detecting mutagens (genotoxicity) has been an important source of information on potential carcinogens. Animal studies have been crucial in identifying human carcinogens and with the exception of arsenic every known human carcinogen is carcinogenic in animals. Human studies have been very important in the qualititative identification of carcinogens, for example, butadiene, chromium, and arsenic have been identified as a result of epidemiologic investigation.

In addition to the traditional approaches the International Agency for Research on Cancer (IARC) and the U.S. EPA now make use of other information on the mechanism of cancer associated with the carcinogenesis of a particular substance. Mechanistic considerations have been important in the classification of a number of chemicals by IARC and EPA is beginning to use this type of information in their determinations. However, a cautionary note is required since we know limited knowledge about the true mechanisms of cancer induction from chemicals. It is important not assume the validity of mechanistic arguments without careful testing of the inherent assumptions underlying the hypothesis. We do not want to rush to judgment on a substance which may have significant public health implications as a result of its use in commerce and the environment.

MTBE

1. *Structure-activity.* Structure activity considerations would result in the carcinogen, formaldehyde, being considered a likely product of biotransformation and degradation, but overall MTBE would not have been predicted to be a carcinogen. Formaldehyde and tertiary butyl alcohol are products of metabolism and degradation.
2. *Genotoxicity.* MTBE is not considered genotoxic, although there is some limited evidence in one assay, which has been associated with the genotoxicity of formaldehyde. Investigators at USC have reported MTBE is positive in the Ames Assay using TA 102, an infrequently used tester strain. These results require further investigation to validate. Formaldehyde is genotoxic.
3. *Case studies* There are no case studies suggesting specific cancers have arisen from MTBE.
4. *Epidemiology.* There are no studies on the carcinogenicity of MTBE in humans, and the limited timeframe of MTBE use would inhibit epidemiologic investigation.
5. *Animal studies.* MTBE, TBA, and formaldehyde have all been found to be carcinogenic in animal studies. Chronic animal bioassays of MTBE have resulted in the identification of lymphomas and leukemias, kidney, testes and liver cancers. Thyroid and kidney tumors derived from the degradation product TBA and nasal cancers have been found in rats exposed to formaldehyde by inhalation.

MTBE is metabolized to tertiary butyl alcohol (TBA) and formaldehyde. Formaldehyde is considered a known human carcinogen and is regulated as such by the Occupational Safety and Health Administration (OSHA). Formaldehyde is a product of atmospheric degradation of MTBE where it would be of more concern than via ingestion in drinking water because of its metabolism. TBA is further metabolized to other products whose toxicity has not been well investigated. The information on metabolism remains somewhat limited.

These data taken together would suggest MTBE should be considered either a probable or possible carcinogen. EPA defines a probable carcinogen as an agent where the epidemiologic evidence is either "limited" or where there is "inadequate evidence" and where there is "sufficient evidence" in animal studies. An agent would be a B1 carcinogen if the epidemiologic evidence is limited and B2 if the evidence

is inadequate. In my view MTBE should be considered a B2 probable carcinogen until further testing resolves the issue further.

The Health Effects Institute and Office of Science and Technology reports on MTBE both consider carcinogenic potency and U.S. EPA has developed a risk assessment. While it may be useful to review the risk assessment values I believe it is premature to make policy decisions based on those risk assessment values until further confirmation of the animal bioassays and resolution of mechanistic issues is completed.

Uncertainties Associated with the Animal Bioassays

There are a number of uncertainties associated with the animal studies which require further investigation.

1. The doses of MTBE were very high which may have caused toxicity and in some cases did cause early mortality in the treated animals. Is MTBE a carcinogen at the lower exposure levels found in the environment? This requires further investigation of the mechanism of carcinogenicity of MTBE.

2. There is evidence that tumors in male rats may be species specific and therefore not relevant to assessment of human risk. The renal tumors may be secondary to alpha–2-micro-globulin nephropathy that is specific to male rats. However, serious questions have been raised about whether this proposed mechanism is a response to exposure or whether it constitutes an adequate explanation for the renal tumors. Based on our understanding of the mechanism of renal tumor formation we cannot disregard these tumors as being species specific at this point.

3. It is not apparent what weight should be given to mouse liver tumors. Mouse liver tumors may result from different mechanistic pathways than human cancers and their relevance to assessing human risk has been questioned. At this stage, however, we cannot assume the liver cancers have no human significance based on mechanistic considerations.

4. A series of issues have been raised about the findings of leukemias and lymphomas in the gavage study of Maltoni. A review of his pathology slides would assist clarification of the questions, but the findings represent very important conclusions until proven otherwise.

Overall, the chronic animal bioassays remain important findings, but further followup studies are required. The HEI report gives the most detailed recommendations for further investigations and they are provided as appendices to this testimony. The recommendations indicate the wide range of health related questions that remain to be addressed. This recommended research will not be completed by 1998–1999, although considerable information could be developed by 1999 if we begin immediately. The State will need to coordinate its activities with U.S. EPA and NIEHS. In my view it is essential for NIEHS to be involved in all health related research. NIEHS should conduct research in contrast to the EPA approach which requires testing done by affected industry. Industry should be asked to contribute to the costs of the research, but independent academic and NIEHS researchers must conduct the studies.

During the time the health and exposure related studies are being conducted there should be an equally energetic investigation of non-toxic substitutes for MTBE.

The Tables included with this testimony are taken from the Health Effects Institute report entitled "The Potential Health Effects of Oxygenates added to Gasoline, A Review of the Current Literature." This was a special report of the Institute's Oxygenates Evaluation Committee.

HEALTH EFFECTS INSTITUTE
THE POTENTIAL HEALTH EFFECTS OF OXYGENATES ADDED TO GASOLINE
A SPECIAL REPORT OF THE INSTITUTE'S OXYGENATES EVALUATION COMMITTEE

Research Priorities for Oxygenates

This review has identified gaps in information that have limited what the HEI Oxygenates Evaluation Committee could conclude about the health effects of oxygenates added to gasoline. The specific research needs in each of the areas evaluated are outlined below. Those that the Committee thought to be of the highest priority for resolving questions about health effects of oxygenates are marked with three asterisks (***), those with moderate priority with two asterisks (**), and those of lower priority with one (*).

A number of studies to investigate further the effects of MTBE and to characterize the toxicity of other ethers are already planned or ongoing (see U.S. Environmental Protection Agency 1995). These are indicated in the appropriate categories

below. In addition, testing for fuel registration, mandated under Section 211 (b) of the CAAA of 1990, will begin soon. The current requirement consists of evaluating the evaporative and combustion emissions from fuels containing oxygenates. The tests to be conducted on the emissions include a 90-day subchronic inhalation toxicity study, reproductive and developmental studies and neurotoxicity assessment and possibly a 2-year carcinogenicity study. The EPA has indicated its interest in modifying these requirements to ask for a more appropriate assessment of the emissions' toxicity. The Oxygenates Evaluation Committee encourages the EPA and industry to consider the following research priorities in developing alternative testing requirements.

Testing of the individual oxygenates falls under the Toxic Substances Control Act. The Interagency Testing Committee designated ETBE and TAME to be tested (Federal Register 1994). As a result of a consent agreement between the EPA and the API, testing of TAME started in 1995 (Federal Register 1995). The research plan includes pharmacokinetic studies. studies of subchronic exposure in two species, reproductive and developmental toxicity, mutagenicity, and neurotoxicity. At this time, a consent agreement has not been agreed upon for ETBE testing. However. ARCO has indicated a commitment to conduct toxicity studies in rats and mice.

EXPOSURE ASSESSMENT

*** A comprehensive set of studies needs to be undertaken to determine levels of personal exposure to oxygenates using standardized protocols. Although more information on MTBE is needed, the need is particularly great for assessing exposure to ethanol, ETBE, and TAME because these compounds are currently in use, or may be soon, and the resulting exposures have not been adequately assessed. These factors should be considered in planning such studies:

Using standardized methods for collecting samples (including the sampler's flow rate, sampling time, analytical methods, and calibration procedures); applying quality control procedures consistently across studies;

Assessing exposures in microenvironments where consumers have the highest-level exposures such as in refueling vehicles, and in occupational settings where significant exposure is likely to occur:

Measuring gasoline components other than oxygenates that might serve as markers for the complex mixture in the ambient air;

Measuring levels of oxygenates and their metabolites (as biomarkers) in blood;

Collecting data at different times of the year, and in areas with different climatic conditions, including extremely low and high temperatures and humidity; and

Identifying sensitive populations and measuring their exposures.

*Environmental sampling data are needed to assess the fate and distribution of atmospheric transformation products of MTBE and other oxygenates such as tertbutyl formats.

*The extent of MTBE contamination of drinking water needs to be analyzed.

METABOLISM AND DISPOSITION

**Further studies of the metabolism of MTBE would be of great value in assessing the health risks from exposure to MTBE and in understanding the importance of differences in the metabolic process in determining sensitivity in individuals. Studies involving exposure to oxygenates as parts of complex mixtures that represent gasoline vapors and motor vehicle exhaust should be conducted to determine the potential interactive effects among gasoline components. lSome research in this area is under way at the Chemical Industry Institute of Toxicology (CIIT). funded by the Oxygenated Fuels Association [OFA], and research will be funded by HEI this year from its recent RFA on "Comparative Metabolism and Health Effects of Ethers Added to Gasoline to Increase Oxygen Content.") Areas to be investigated include:

The kinetics of TBA, formats, and formaldehyde formation and the role of the cytochrome P-450 enzymes in metabolizing MTBE and TBA;

The metabolic fate of TEA in response to concerns about the potential toxicity of possible metabolites and of free radicals produced during oxidative metabolism.

**Pharmacokinetic studies need to be extended to the other ethers, especially ETBE and TAME. (HEI is planning to fund studies to compare MTBE with other ethers. Also, for TAME, pharmacokinetic studies are being conducted to comply with regulations specified in the Toxic Substances Control Act.)

*Studies that compare inhalation and oral exposure should be conducted to determine the kinetics of uptake and disposition of ethanol in human subjects at concentrations expected to be encountered }n ambient air. This information would en-

hance confidence in the current conclusion that ambient air exposures would not result in a significant increase in blood levels of ethanol.

SHORT-TERM EFFECTS

***Controlled human exposure studies should be conducted to assess the short-term effects of MTBE. other ethers, and ethanol in a hydrocarbon mixture that is representative of gasoline, and compare subjects' symptomatic reactions to that mixture with reactions to the hydrocarbons alone.

Studies should include potentially sensitive subjects, such as individuals who have reported symptomatic responses to exposure to oxyfuel, as well as other groups hypothesized to be sensitive , perhaps individuals who have allergies or who are elderly. The effects of exercise should be assessed. (Studies of individuals who have reported a sensitivity to MTBE are under way or planned at the EPA and the Environmental and Occupational Health Sciences Institute.)

Blood levels of the oxygenates and pertinent metabolites should be measured in these studies to understand the relationships among exposure, dose, and effects and to compare with levels measured in real-life situations.

For MTBE, these studies should also evaluate possible neurotoxic effects at several exposure levels using sensitive tests to measure complex central nervous system functions.

**Epidemiologic studies should be conducted to evaluate in the general population the short-term effects of MTBE, other ethers, and ethanol as gasoline additives. The limitations of the currently available information on the short-term effects of MTBE have been discussed in depth in the previous sections. The community based studies provide an indication of what symptoms might be encountered and insights concerning hypotheses to be tested. Future studies should aim at providing information on the relations between activities and exposure, exposure and biomarkers of dose, and dose and health outcomes. Several types of efforts would be informative concerning potential health consequences of MTBE:

Longitudinal studies are needed that prospectively collect daily symptom reports before and after oxygenates are added to fuel in various geographical areas;

Protocols should be developed for studies of symptom outbreal;s, including standardized questionnaires for symptoms and for assessing factors that may predispose wme individuals to these symptoms;

Study designs should be developed to assess what factors define susceptibility and to identify susceptible subgroups;

Occupational studies of workers involved in producing, handling, or transporting MTBE would provide useful information about a broader range of exposure and situations than those encountered by the general population:

Consideration should be given to studies of outcomes other than symptoms, including neurobehavioral effects (such as reaction times, attention, and vigilance) and immunologic effects [such as T-cell counts).

Hybrid protocol design that bring individuals from the community into laboratory investigations involving controlled exposure also may be informative.

**Animal studies at relevant exposure levels also may be helpful in investigating the neurotoxic and other effects of MTBE and as a screening tool for other ethers. Behavioral tests that explore a broad range of complex motor, sensory, cognitive, and motivational measurements should be used. These studies should include measuring blood levels of MTBE and reporting, for dose-response relationships, a measurement such as a 10 percent change in performance, which would then be the precursor to a benchmark dose calculation.

LONG-TERM EFFECTS

***Epidemiologic studies of workers who have been exposed to MTBE since the early 1970's should be conducted to determine whether the frequency of some types of tumors is increased in this population, as has been reported in animal studies.

***To determine the potential neoplastic and nonneoplastic effects of MTBE as part of a complex fuel mixture, studies involving long-term exposure to MTBE in gasoline should be conducted in rats and mice.

***To interpret the carcinogenic results from studies of MTBE in animals and extrapolate them to assess human risk, the following studies are needed:

Studies should be conducted to investigate whether significant amounts of genotoxic metabolites are formed in organs in which tumors were observed in studies of long-term exposure to MTBE. Particular attention should be paid to formaldehyde, metabolites of TBA, and their putative macromolecular adducts.

Studies should investigate whether the MTBE-induced tumorigenic responses can be explained by any of the mechanisms that have been suggested. For example, it

has been argued that some of the tumors in the liver, testis, and thyroid induced with nonmutagenic carcinogens may result from endocrine disturbances caused by high doses of the test compounds or, in the case of the kidney, from a species- and gender-specific mechanism that is not relevant to humans. (Some of these studies are being conducted at CIIT. funded by OFA).

DEVELOPMENTAL EFFECTS

*Although the effects of MTBE on developmental processes seem to occur only at high doses at which maternal toxicity also is observed, studies of developmental effects of MTBE have not included extensive behavioral testing. Behavioral assays on the offspring of pregnant rodents exposed to MTBE by inhalation, or on preweanling newborns exposed to MTBE, should be conducted. They should explore a broad range of complex motor, sensory, cognitive, and motivational measures. (Developmental studies of neat TAME are currently being conducted as part of the TSCA requirements.)

HEALTH EFFECTS RESEARCH ON ETHERS OTHER THAN MTBE

*** A comprehensive plan including, but not limited to, the types of studies listed under the various areas of research should be developed for investigating the health effects of other ethers. They should be based on the current knowledge of the effects of MTBE and on the results of pharmacokinetic studies of MTBE and other ethers. (Toxicity testing of TAME is in process under TSCA, and some work on ETBE in rats and mice will be funded by ARCO [90-day subchronic study, neurotoxicity screening!.)

Compound and References	Species	Route of Exposure	Gender	Tumors Showing a Statistically Significant Increase in Incidence						
				Kidney	Testes	Liver	Lymphomas and Leukemias	Thyroid	Nasal Cavity	Gastro-intestinal Tract
MTBE										
Chun et al. 1992	Rat (F344)	Inhalation	M F	+	+					
Belpoggi et al. 1995	Rat (Sprague-Dawley)	Gavage (in oil)	M F		+		+			
Burleigh-Flayer et al. 1992	Mouse (CD-1)	Inhalation	M F			+ +				
TBA										
Cirvello et al. 1995	Rat (F344)	Oral	M F	+						
	Mouse ($B6C3F_1$)	Oral	M F					+		
Formaldehyde										
Several studies reviewed by IARC 1995	Rat	Inhalation	M F						+ +	
Three studies reviewed by IARC 1995[a]	Rat	Oral	M & F				±			±

[a] A + in this row indicates that both positive and negative data were presented in the studies reviewed.

Table 33. Incidence of Kidney Tumors in Male F344 Rats Exposed to MTBE by Inhalation[a]

Dose (ppm)	Adenoma[b]	Carcinoma[b]	Adenoma or Carcinoma[b]
0	1/50	0/50	1/50
400	0/50	0/50	0/50
3,000	5/50	3/50	8/50
8,000	3/50	0/50	3/50

[a] Chun et al. 1992.
[b] Number of animals with tumors/number of animals in the exposure group.

Table 34. Incidence of Testicular Interstitial Cell Neoplasms in Male F344 Rats Exposed to MTBE by Inhalation[a]

Dose (ppm)	Adenoma[b]
0	32/50
400	35/50
3,000	41/50
8,000	47/50

[a] Chun et al. 1992.
[b] Number of animals with tumors/number of animals in the exposure group.

Table 32. Incidence of Tumors in Sprague-Dawley Rats Exposed to MTBE by Ingestion[a]

Dose (mg/kg)	Males Testicular Interstitial Cell Adenomas		Females Lymphomas or Leukemias	
0	2/60[b] (3%)	2/26[c] (8%)	2/60[b] (3%)	2/58[c] (3%)
250	2/60 (3%)	2/25 (8%)	6/60 (10%)	6/51 (12%)
1,000	11/60 (18%)	11/32 (34%)[d]	12/60 (20%)	12/47 (26%)[e]

[a] Belpoggi et al. 1995.
[b] Data in this column reflect the number of animals with tumors/the number of animals at the start of the study.
[c] Data in this column reflect the number of animals with tumors/the number of animals surviving at the time when the first tumor of this type appeared.
[d] Significantly different from the 0-mg/kg group ($p < 0.05$).
[e] Significantly different from the 0-mg/kg group ($p < 0.01$).

STATEMENT OF JORGE R. MANCILLAS, BEFORE THE CALIFORNIA STATE SENATE ENVIRONMENTAL QUALITY COMMITTEE BILL UNDER CONSIDERATION: SB 1189, MAY 12, 1997

Introduction

The decision as to the fate of MTBE has serious economic and public health ramifications. The argument that phasing out MTBE as an additive in oxygenated fuels would have serious economic consequences is based on the fact that-large amounts of MTBE are used in California and throughout the country. It is this widespread Use, however, that provides the risk of exposure to a population of over 100 million Americans and requires that any potential or established risk to public health be taken with the outmost seriousness. Similarly, one can not make the argument that sufficient amounts of MTBE are being used widely enough to pose a risk to human health without acknowledging that any decision as to its future use must take in consideration its economic consequences.

The best way to arrive at a policy decision regarding the future of MTBE as a gasoline additive is to rely strictly on solid science and careful and well-supported analysis of economic impact. Policy is best when based on fact, not fear, communication and cooperation, rather than cohersion.

The goal should be to protect the health of our citizens, the integrity of our natural environment, and the solvency of the economic institutions that provide an adequate supply of fuels. Enlightened policy does not require that any of those objectives be brushed aside. Any proposals should include measures to insure prevention of harm to human health and thoughtful consideration of how to best handle the economic and environmental consequences of any changes in current policy.

This testimony is intended to underscore tile urgency of dealing with the potential risks to public health posed by the use of MTBE as an additive in oxygenated fuels. Concern during policy discussions has centered on risks of carcinogenicity, based on evidence in the peer-reviewed literature of MTBE's carcinogenic potential with chronic exposure to high enough doses in animal studies. Claims have also been made of associations with other pathological conditions which may merit further investigation.

My testimony, however, focuses on the primary effect of MTBE on the human body: alteration of nervous system function. The view that the use of MTBE poses a significant risk of neurotoxic effects and that this is an immediate public health concern is based on:

- the fact that MTBE is a neuroactive substance (section 1 of this written testimony)
- known plausible cellular mechanisms by which it disrupts normal function (section 2)
- animal studies which document its neurotoxicity (section 4a) and
- human epidemiological studies which document observed adverse effects symptomatic of nervous system disruption after exposure to MTBE (section 4b)

1. MTBE Belongs to a Class of Neuroactivesubstances

MTBE (Methyl Tertiary Butyl Ether) is an ether. Ethers are neuroactive.

Ethers were first isolated over 150 years ago and became of interest because of their ability to produce anesthetic effects in humans. Ether was first used as an anesthetic by dentist William Horton in Boston in 1846. It has been replaced as an anesthetic because the chemical characteristics that make some ethers useful as a gasoline additive, their flammability, created fire risks.

The organs first and most abundantly perfused with MTBE once it reaches the bloodstream after penetrating the body either through inhalation, ingestion or dermal absorption are the brain, kidney, and liver. The first biological target of MTBE and the organ most sensitive to its actions is the nervous system.

2. Mechanism of Actions: MTBE Affects Nerve Cells by its Effects on Membrane Fluidity

Cell membranes are lipid bilayers. MTBE, because of its solubility in lipids, alters membrane fluidity, potentially affecting all cells in the body. Nerve cells are more sensitive to agents which disrupt membrane integrity because their function is performed by membrane-bound molecules:

Transmission of information by nerve cells is accomplished through: a) generation of electrical impulses (action potentials) by changing conductances of ion channels (which are proteins extending through their membranes); b) through secretion of neurotransmitters at the end of nerve fibers (another process which depends on cell membrane integrity); and c) through responsiveness to neurotransmitters by receptor molecules inserted in the membranes of their dendrites.

The question then is, if MTBE is neuroactive, is there a significant risk of neurotoxic effects for humans at current levels of exposure?

3. In 1988 ITC Found MTBE to Pose an Unreasonable Risk of Neurotoxicity

In March 1988, the Interagency Testing Committee (ITC), after review of a number of substances which included MTBE, gave MTBE an "A" finding. An "A" finding was assigned to substances which present an unreasonable risk of neurotoxicity and for which there is substantial human exposure.

The "A" finding on MTBE required conducting a core test battery for neurotoxicity, including a functional observational battery, motor activity tests, and neuropathological evaluations after acute and subchronic exposure.

The ITC is a multidisciplinary advisory panel composed of one member of EPA, OSHA, Council on Environmental Quality, NIOSH, NIEH, NCI, NSF and the Department of Commerce. It issued 24 reports to EPA between 1977 and 1989, proposing 100 chemicals for inclusion in the priority list testing under section 4 of TSCA. Its finding on MTBE came before it was used as a gasoline additive as extensively as it is now and before its use became controversial.

After negotiations with industry, EPA (Office of Toxic Substances) issued a consent decree (March 1988, Federal Register, volume 53–10391) mandating neurotoxicity evaluation. Industry proposed testing to be performed by the Bushy

Run Research Center, owned by Union Carbide. Tests were completed and a report written in September 1989 (Report 52–533, September 19, 1989). The results indicate MTBE has neurotoxic effects.

4. MTBE is Neurotoxic

4a. Animal inhalation studies reveal neurotoxic effects of MTBE

The Bushy Run Research Center studies, conducted on rats exposed to 4 concentrations through inhalation (0, 8900, 4,000 and 8,000 ppm) showed that MTBE caused depression of Central Nervous System activity which was more apparent at higher doses.

Among the effects observed after acute exposure were:

- ataxia
- duck walk gait
- labored respiration
- decreased muscle tone
- decreased body temperature
- decreased treadmill performance
- decreased hind-limb grip strength
- increased hind-limb splay, piloerection and lacrimation
- increased mean latency to rotate on an inclined screen

In the studies after sub-chronic exposure:

- Effects similar to those caused by acute exposure were observed although the authors questioned their toxicological significance.
- Significant changes in body temperature, motor activity and fore limb strength were observed.
- Absolute brain weight was lower in animals exposed to 8,000 ppm. Unfortunately, the authors did not examine or report what specific cell populations in the central nervous system account for the brain weight loss.

Given the results of animal studies, does MTBE pose a risk of neurotoxicity in humans at the exposure levels resulting from its use as a gasoline additive?

4b. Human epidemiological data shows a correlation between routine exposure to MTBE and symptoms of nervous system disruption

In response to the 1990 amendments to the Clean air Act, Alaska converted to the use of oxygenated fuel containing 15 percent by volume MTBE in mid-October 1992. MTBE had not previously been added to gasoline in Alaska either as an octane enhancer or as an oxygenate.

Within the first 3 weeks of November 1992, reports of headaches, dizziness and nausea poured into a local telephone hotline.

In response to the complaints, a study was conducted by the Alaska Department of Health and Social Services and the Centers for Disease Control in December 1992, and January and February 1993.

Workers who were exposed in the workplace and commuters subjected to non-occupational exposure were evaluated while MTBE was in use and after use of oxygenated fuels was suspended in Alaska.

- Air concentrations of MTBE were monitored.
- Blood levels of MTBE in the subjects was measured.

Results:

- In areas where MTBE was added to gasoline, MTBE was detectable in the blood of occupationally exposed persons and the general public.
- Persons exposed to and with higher blood levels of MTBE more frequently reported headaches, eye irritation, nausea, dizziness, burning of the nose and throat, coughing, spaciness or disorientation, and vomiting, compared to those with lower blood levels of MTBE.
- Exposure to gasoline without MTBE did not result in increased symptoms.

4c. Policy results of the CDC and Alaska's DHSS epidemiological studies

Use of oxygenated fuels with MTBE was suspended in Alaska.

Alaska has been able to comply with the requirements of the Clean Air Act. Measures other than the use of reformulated gasoline, including comprehensive inspection and maintenance program resulted in a dramatic improvement in air quality and allowed for an immediate suspension of the use of MTBE while alternatives were sought. Ethanol was later introduced as a replacement for MTBE in Anchorage.

4d. Symptoms of nervous system disruption have been reported in several States

Complaints indicative of adverse health effects similar to those reported in Alaska have been reported in Montana, New Jersey, Wisconsin, Maine, Connecticut, Pennsylvania, Texas and Colorado.

In April 1993, the Centers for Disease Control conducted studies in Stamford Connecticut similar to those in Alaska with the cooperation of the Connecticut Health Department. Again, the subjects with the highest blood MTBE levels had a higher incidence of symptoms of disruption of nervous system function.

A study conducted in Albany, New York yielded negative results. Comparisons may be misleading, however, because the blood levels of MTBE were significantly much lower than in Alaska and Connecticut (levels for gasoline station attendants, for example, were 15.19 micrograms per liter in Stamford vs. 0.42 micrograms per liter in Albany). A study comparing selected populations of southern and northern New Jersey did not include analysis of blood samples and its results are therefore more difficult to interpret.

4e. Original studies indicating neurotoxic effects of MTBE have been misrepresented or ignored: A cautionary note

The results of the Alaska studies have been misrepresented by CAL EPA in its April 1997 report (p. 9) when stating that they "were unable to associate them [complaints] with MTBE exposure." The authors of the studies strongly object to that characterization. Reviews by Federal agencies have tried to downplay the results.

Similarly, a November 1993 review by the ORD of the US-EPA misrepresents the Stamford CDC studies by creating categories of subjects which dilute the results. Whereas the relevant correlation to examine is that between blood levels and symptoms of adverse effects, they compare the median of one or another occupational category, diluting the strength of the correlation between MTBE blood levels and health effects. That and other reviews give equal or more weight to negative results in Albany than to those obtained in Alaska and Stamford, with complete disregard to the clear differences in blood levels.

Whatever the intent is, one should be cautious and not rely on "reviews" and "assessments" of the literature but consult the original studies, with a definite preference for studies the results of which have been published in peer-reviewed journals. The only reliable measure of exposure is a quantitative and pharmacokinetic analysis of blood levels, with measurement of symptoms at relevant time points in relation to changes in blood levels. Guesses about exposures based on measurement of air levels are misleading and at best dilute the results.

If the results of the studies mentioned in 4a and 4b are indicative of neurotoxic effects of MTBE, why is there such little public awareness and reporting of adverse health effects?

5. Neurotoxic effects commonly go undetected and their cause unidentified

One of the major problems in establishing the risk of neurotoxicity for a human population is that irreversible neurotoxic effects are often not detected, nor accurately diagnosed. Even in the case of reversible, acute effects, the association of overt symptoms with exposure to the causative agent is rarely established. Usually, no one is looking for them and neither the public nor most doctors are trained to identify, recognize and interpret symptoms of neurotoxicity.

Damage to the nervous system is more commonly expressed as loss of nerve cells, or impaired peripheral nerves, as opposed to visible abnormal growth as it is the case with cancer. Loss of neural tissue does not cause detectable biochemical changes that can serve as indicators.

Doctors are not taught in medical school to look for neurotoxic effects. When patients complain doctors rarely conduct assays for the presence of neurotoxic substances in blood samples. It is also extremely rare, for example, for a doctor to have the equipment to measure speed of conduction of peripheral nerves.

Nervous tissue is the most delicate, vulnerable and irreparable of all tissues. While other tissues can regenerate, a lost nerve cell is lost forever. Nerve cells can not divide. They are not replaced. Thus, damage to the nervous system is irreparable and cumulative.

Often, as attested by even serious debilitating diseases, like Parkinson's disease or Alzheimer's disease, neuropathies do not present an immediate risk of death. Yet they harm the most essential, intimate human organ, that associated with all uniquely human qualities: the brain.

The impact on an individual's quality of life when an impairment is sustained in memory, intelligence or motor skills is incalculable. The cumulative effect for society of diminished intellectual capacity (analytical abilities, information processing abili-

ties, memory, intelligence) at the level of a population is hard to assess. The devastating emotional impact is clear for those with relatives or friends suffering from neurological diseases.

As long as systematic, comprehensive epidemiological studies are not conducted with human populations currently exposed to inhalation or ingestion of MTBE in the air or contaminated water, uncertainty will remain about the possibility of neurotoxic effects for the general population or for specially vulnerable sub-populations.

At best, a massive experiment is being conducted and no one is collecting the data. At worst, significant neurological damage is being sustained by segment of the population with unknown and possibly immeasurable consequences.

6. Additional brief notes regarding risk of exposure

6a. Environmental fate

Gasoline contains other components long recognized as hazardous for human health. Therefore, people will tend to exercise some degree of caution when handling reformulated gasoline. The discovery of MTBE contamination in wells, however, raises additional concerns. When leakage from underground tanks or pipes occurs, MTBE diffuses faster and farther than other gasoline components and it stays in the environment longer. Its solubility in water and its high partition coefficient with soil allows it to diffuse faster than other components of gasoline and its rate of degradation is slower, especially when not vulnerable to photolysis. People may be exposed to MTBE without their knowledge. Exposure to low levels of MTBE by ingestion increases the exposure burden already present through inhalation.

6b. Degradation products of MTBE and additional risks of prolonged exposure

The two main products of MTBE degradation are toxic. As MTBE degrades and ceases to directly pose a risk it creates substances, formaldehyde and TBA (Tertiary Butyl Alcohol), which pose well documented risks to human health.

The enzyme that catalyzes MTBE in the human body saturates. Therefore larger doses or prolonged exposure does not only have a cumulative effect but exposure to additional MTBE poses a larger risk.

7. Policy Recommendations

The safest course of action would be to responsibly phase out MTBE and replace it with a safer alternative. If this alternative is chosen, sufficient time should be allowed for an orderly and cost-effective transition to alternatives which would accomplish the same fuel-efficiency and clean-air goals.

While MTBE use in reformulated fuels is phased out, as long as any significant amounts remain in the environment (i.e., in contaminated wells) or if MTBE continues to be used as a gasoline additive, minimum protective measures should include:

1. Strict monitoring of levels of MTBE and its degradation products—in particular TBA and formaldehyde—in the air and water.
2. Thorough monitoring of MTBE and TBA blood levels when there is likelihood of exposure.
3. Require industry to effectively inform residents or workers in areas where MTBE is present of what are the symptoms associated with MTBE exposure. Provide hot-line to take in reports.
4. Serious epidemiological investigation of complaints of adverse health effects.

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DEPARTMENT OF HEALTH AND HUMAN SERVICES,
PUBLIC HEALTH SERVICE, CENTERS FOR DISEASE CONTROL,
Atlanta, GA, August 12, 1993.

HON. JOHN A. SANDOR
Commissioner, Department of Environmental Conservation
Juneau, Alaska 99801–1795

DEAR MR. SANDOR: Enclosed please find an interim report that describes the epidemiologic investigations on human exposures to methyl tertiary butyl ether (MTBE) conducted by the Centers for Disease Control and Prevention (CDC) in collaboration with the Alaska Department of Health and Social Services and the Alaska Department of Environmental Conservation in Fairbanks, Alaska.

Our major findings were:

1. In areas where MTBE was added to gasoline MTBE was detectable in teh blood of both occupationally-exposed persons and the general public.
2. Persons with higher blood levels of MTBE more frequently reported symptoms, including headache, nausea, burning of the nose and throat, and spaciness, compared to those with lower blood levels of MTBE.
3. Exposure to gasoline without MTBE did not result in increased symptoms.
4. We believe that until MTBE is fully evaluated in community-based studies, questions will remain as to its safety for widespread distribution and use.

Thank you for the opportunity to work with you to investigate the illnesses in Fairbanks. As you know, we discovered a similar relationship between higher blood levels of MTBE and symptoms in Stamford, Connecticut. The consistency between the two study sites adds strength to these findings.

We hope this interim report will be helpful to you. We believe it raises questions which must be resolved in future investigations.

Sincerely yours,

RUTH A. ETZEL, M.D. PH.D.
Chief, Air Pollution and Respiratory Health Branch,
Environmental Hazards and Health Effects,
National Center for Environmental Health.

RESOLUTION PASSED BY THE AMERICAN MEDICAL ASSOCIATION

June 14, 1994, Chicago, IL

Subject: Moratorium on Methyl Tertiary Butyl Ether Use as an Oxygenated Fuel in Alaska

Whereas, The Clean Air Act Amendment of 1990 required the use of oxygenated fuel in winter in all areas which exceed the National Ambient Air Quality Standard (NAAQS) for carbon monoxide (CO), an Anchorage and Fairbanks were two of the 39 cities required to use oxygenated fuel in the 1992–1993 winter season; and

Whereas, in Fairbanks and Anchorage in 1992–1993 a large number of citizens complained of symptoms including headaches, dizziness, nausea, cough, and eye irritation; and studies by the Alaska Division of Public Health and the National Centers for Disease Control and Prevention found that these symptoms were associated with exposure to oxygenated gasoline, that MTBE was detectable in the blood of all workers and communities studied in Fairbanks, and that the association between symptoms and exposure to MTBE in gasoline needs further study; and

Whereas, limited scientific evidence raises questions about the potential carcinogenicity of MTBE; and

Whereas, the Alaska Division of Public Health recommended in reports released in December 11, 1992 and December 23, 1992 that the oxygenated fuels programs in Fairbanks and Anchorage, respectively, should be suspended; and

Whereas, results of recent scientific studies suggest that addition of MTBE to gasoline does not lower CO emissions from motor vehicle exhaust at temperatures below 0 degrees; and

Whereas, a dramatic decline in CO levels in ambient air in Anchorage and Fairbanks occurred before the implementation of the oxygenated fuels program as a result of the existing inspection and maintenance program and replacement of aging vehicles without using MTBE; and

Whereas, based on current ambient air CO levels in Anchorage and Fairbanks, characteristics of population, condition of temperature and darkness, and low opportunity for exposure, no beneficial public health effects can be expected from further minor reductions of ambient CO levels that might result from the use of MTBE, therefore be it

Resolved, that the American Medical Association urge that a moratorium on the use of MTBE-blended fuels be put into place until such time that scientific studies show that MTBE-blended fuels are not harmful to health, and that no penalties or sanctions be imposed on Alaska during the moratorium.

RESOLUTION CONCERNING THE USE OF OXYGENATED FUELS IN ALASKA

American Public Health Association, November 2, 1994

Knowing that the Clean Air Act Amendment of 1990 required the use of oxygenated fuel in winter in all areas which exceed the National Ambient Air Quality Standard (NAAQS) for carbon monoxide; and

Knowing that Anchorage and Fairbanks, Alaska were 2 of 39 areas required to use oxygenated fuel in the 1992–1993 winter season; and

Knowing that more than 100 million Americans are being exposed to methyl tertiary butyl ether (MTBE), a fuel additive, and its combustion products; and

Knowing that the use of oxygenated gasoline with methyl tertiary butyl ether (MTBE) in Fairbanks and Anchorage in 1992–1993 led to a large number of citizen complaints of headaches, dizziness, nausea, cough, and eye irritation; and

Aware that scientific studies by the Alaska Division of Public Health and the National Centers for Disease Control and Prevention found that these symptoms were associated with exposure to oxygenated gasoline, that MTBE was detectable in the blood of all workers and communities studied in Fairbanks, and that the association between symptoms and exposure to MTBE in gasoline needs further study; and

Recognizing that results of recent scientific studies suggest that addition of MTBE to gasoline does not lower CO emissions from motor vehicle exhaust at temperatures below 0 degrees Fahrenheit; and

Knowing that a dramatic decline in CO levels in ambient air in Anchorage occurred before the implementation of the oxygenated fuels program in the winter of 1992–1993, and it is predicted that within 1 to 3 years Anchorage will meet NAAQS CO standard as a result of th existing inspection and maintenance program and replacement of aging vehicles without using MTBE; and

Believing that based on current ambient air CO levels in Anchorage and Fairbanks, characteristics of the population, condition of temperature and darkness, and low opportunity for exposure, no beneficial public health effects can be expected from further minor reductions of ambient CO levels that might result from the use of MTBE in Alaska, and

Believing that similar circumstances my exist in other States; therefore

1. Calls upon the U.S. Congress to take appropriate action to ensure that adequate scientific studies are funded and conducted on oxygenated fuels, including studies of potential toxicity of MTBE by the National Toxicology Program, a study of the comparative health benefit of using oxygenated fuels by the Institute of Medicine, studies of health effects from exposure of workers to MTBE by the National Institute of Occupational Safety and Health, and studies of health effects among the general public from exposure to oxygenated fuels by the National Center for Environmental Health, Centers for Disease Control and Prevention; and

2. Calls upon the U.S. Congress to take appropriate action to delay imposition of sanctions under the Clean Air Act amendment for carbon monoxide exceedances upon the State of Alaska for a 3-year period while scientific studies of MTBE in arctic conditions are conducted and evaluated.

STATEMENT OF HON. RICHARD MOUNTJOY, STATE SENATOR FROM CALIFORNIA

Thank you for the hearing, and it does give the people of California a voice directly to the U.S. Congress, and we appreciate that very much.

Our original bill called for an outright ban of MTBE and then later, through the legislative process, 521 was watered down to a study, but a good study on MTBE. But even at the time that that went through we were saying that we believed, because of the public outcry and the poisoning of our water here in California, that MTBE would, in fact, be phased out prior to the completion of that study.

I think both Senator Hayden and I have been involved in this issue to the extent that we pretty much knew what was coming down, regardless of what the political factors were here in the State Capitol.

This water I have here is out of some wells in the City of Glenville. This well is contaminated to the levels of 200,000 parts per billion. Most of the wells in that city have been contaminated to the levels of 20,000 parts per billion, hardly something—I wouldn't—well, you can smell it if you choose to, but not for too long.

It has almost destroyed property values, and you have to remember that this little city is uphill from Bakersfield. Getting into the deep water aquifers and flowing downstream into Bakersfield could be very, very dangerous.

We have found that MTBE is in Lake Tahoe. There are lakes—and a lot of this, you know, is laid off on the boats. Well, we have the boats on the lakes and they're spewing fuel into the lakes. But you need to know that Lake Merced, in the Bay Area, is contaminated with MTBE and only has on it either boats that are rowed by hand or electric motors, so MTBE also gets in. I think you'll hear a little more about that from the geological survey folks and some of the other expert witnesses that you're going to have here today. MTBE is a threat.

In the San Gabriel Valley we have spent considerable money and time over the last 20 years cleaning up our wells from other contaminates in that valley, and now they have the threat of MTBE invading that valley, a chemical that once in the water is soluble in the water and, therefore, flows through filters, no really good way to clean MTBE out of the water.

Metropolitan Water told me that if they were to clean up MTBE—and they feel that they have to get it out of the water at the level of 5 parts per billion, and I know EPA is now saying 30 to 40 parts are safe, I believe zero is really safe.

You taste MTBE at around 5 parts per billion. Metropolitan Water feels that they cannot sell water that you can taste, therefore, to clean MTBE out of the water their estimates are triple the water rates for the people of the Los Angeles area if they were to have to clean MTBE out of the water to the level of which you could not taste it. And, so, it's a very, very large threat to our water supply system in Southern California and across this State, and across the nation. We now know that it's in Texas. We've heard that high levels in, of course, Pennsylvania, and you've mentioned most all of those areas. So it is a national threat to our nation's water supply, which is very precious.

There is also the point that many of the people involved in the oil industry have said it isn't doing that much for the air, that the benefits to the air quality are very, very minute compared to the threat of the contamination of the water supply. For that reason alone I believe that the EPA should be urged to take immediate steps to either, No. 1, ban would be my, of course, first choice, or to at least relieve California of the necessity, or relieve the nation of the necessity, of oxygenating fuel at all, and try to clean it up either with another oxygenate of their choice or clean it up without any oxygenate at all, to get to the levels that are necessary.

Many of them believe they can achieve that goal, and I think they ought to be allowed to turn their experts loose to try to. Once in the water and once in the ground—you mentioned the fact, which is true—very, very, long biodegradation of MTBE. Benzene, generally speaking, 400 feet from a tank, is going to biodegrade. MTBE, not so. It will travel through the water aquifers just as it if were water.

The fact of life is that in Glenville the contamination was caused by leaking tanks and spillage of—while filling the tanks, new tanks, by the way. So we know that MTBE—it's not a question, are the tanks going to leak, it's—the question is when they're going to leak and how much are they going to leak.

We saw a pipeline over Donner Pass in which started a leak, they estimated sometime in October. It was not even detected until March, a pipeline that had some 900 pounds of pressure in it. So we don't know the extent of the leakage in the Donner Pass area of that pipeline. So pumping MTBE through those lines is a very, very dangerous situation, and one that we believe needs to be—steps taken immediately.

I'm pleased to see companies like Tosco and Chevron are now willing to step forward and say we ought to have some alternative to MTBE because it is dangerous to our water supply.

Now, we all want clean air, and I believe we need to say on the course of attaining as clean an air as we can attain, however, at the same time we cannot afford to contaminate our precious water supply here in the State of California.

As you mentioned before, every drop of water in California is very, very precious to us and we need to do everything we can to protect our supply.

So just let me end by saying thank you so much for the hearing. I hope that our message is heard by the Congress of the United States and by the EPA, and that immediate steps are taken to stop the health risk that is going on.

Senator Hayden mentioned that there is a study ongoing, but the study involves 32 million Californians as guinea pigs, and that's something I don't believe we can afford.

So thank you again for the hearings and my chance to participate. I do have some documents from different water companies that are not going to be able to participate today, but I would like to submit these documents to you for entrance into the

official record, and they are the positions of several water companies in the State of California.

STATEMENT OF CRAIG PERKINS, DIRECTOR OF ENVIRONMENTAL AND PUBLIC WORKS, SANTA MONICA, CA

Good morning Senator Boxer. My name is Craig Perkins and I am the Director of Environmental and Public Works Management for the city of Santa Monica. In this capacity, one of my major areas of responsibility is management of the city's water production and distribution system. Over the past 2 years, this job has been made very difficult due to the impacts of MTBE contamination. You are probably well aware of the MTBE crisis that Santa Monica has faced over happened and what remains to be done.

In late 1995 and early 1996, we first became aware that a new contaminant might be impacting the city's drinking water wells. In early February, 1996 we indeed confirmed that several of our wells had been contaminated with MTBE. Between February and October 1996, we shut down seven of the city's 11 water wells at two separate well fields because of the contamination. These wells had represented 71 percent of our local water well production and supplied about one half of Santa Monica's total daily water demand. At the time one of the first wells was shut down, the MTBE contamination had soared to 610 parts per billion (μg/L), nearly 20 times the state action level. Clearly, the present situation represents an environmental crisis that has been a staggering blow to the city of Santa Monica both in financial terms and from the standpoint of an almost total loss of our reliable local water supply which has been of critical into during natural disasters such as the 1994 Northridge earthquake and other emergencies.

As a result of the MTBE contamination, in June 1996 the Santa Monica City Council approved a 25 percent emergency MTBE surcharge on every water customer to pay for the additional $3.25 million in annual costs for the purchase of outside water to replace the lost well production. These surcharge revenues have not, however, covered the city's considerable legal and technical analysis costs.

Santa Monica's major wellfield which is impacted, the Charnock wellfield, presents a classic example of a multiple party groundwater contamination problem. The city and the Regional Water Quality Control Board have identified 26 "priority" sites in the vicinity of the Charnock wellfield, including two gasoline product pipelines, which may be sources for the MTBE contamination. Considerable technical assessment and evaluation will therefore be required before actual cleanup can commence. The Arcadia wellfield is the other location which has been impacted by MTBE, and at this site there is only one party, Mobil Oil, who has caused the contamination.

What was particularly difficult to deal with during the early stages of this unfortunate episode were the significant gaps in information about the potential public health and environmental impacts from MTBE as a water contaminant, and the distressing absence of technical and regulatory assistance from those state and Federal agencies entrusted with oversight of water quality and groundwater protection issues. As local government officials, we were forced to arrive at our own conclusions about whether MTBE contaminated water should be delivered to our citizens. No enforceable water quality standards for MTBE existed in early 1996. In the face of this regulatory vacuum, we made the decision to shut down the wells and take no chances with the health and safety of our community.

Following many months of negotiations with the two oil companies who exercised good corporate responsibility and stepped forward to discuss the city's MTBE problem, Santa Monica entered into an interim agreement with Shell and Chevron in July, 1997 which reimbursed us for 75 percent of the MTBE costs associated with the Charnock wellfield. This interim agreement enabled the City Council to reduce the emergency MTBE water surcharge by one-half. The agreement will expire in January, 1998 unless renewed by these and/or other oil companies at a 100 percent reimbursement rate. At Arcadia, ironically, where the culpability of Mobil Oil is clear, negotiations between the city and Mobil broke down approximately a year ago resulting in a lawsuit filed by Santa Monica against Mobil in February, 1997. This lawsuit is being pursued by the city in the face of continued recalcitrance on the part of Mobil to admit to their responsibility for the problem.

It has become clear to Santa Monica that MTBE is a potent and pernicious threat to drinking water in California as well as other parts of the United States. Although MTBE has only been in widespread use since the early 1990's, and even though testing for MTBE has not been required until very recently, MTBE has now been found in almost 4 percent of California drinking water systems sampled. We believe

that these findings represent just the tip of the iceberg in terms of the MTBE that may be on its way. It is important to note that Benzene which has been a constituent in gasoline for several decades is rarely detected in wells, yet MTBE in a few short years has already managed to knock out 71 percent of Santa Monica's wells.

With hard work and perseverance, Santa Monica will eventually overcome this crisis, but actions can be taken at the Federal and state level which could greatly facilitate our progress on the path toward restoration of our drinking water supply. At the Federal level, we believe that the action agenda should include the following:

1. Adoption of clear and enforceable drinking water standards for MTBE by the earliest possible date;

2. Strengthening of installation, monitoring and testing requirements for underground gasoline storage tanks and pipelines to respond to MTBE's more alarming fate and transport characteristics;

3. Adoption of strict liability standards for those responsible for MTBE contamination to ensure that the polluter, not the victim, pays for damages and cleanup costs;

4. Implementation of testing requirements for MTBE at all leaking underground storage tanks and in all public drinking water supplies throughout the United States so that we know as soon as possible how big a national problem MTBE has become and can better prevent the replication of Santa Monica's experience: and

5. Evaluation of whether performance-based clean air standards for auto fuel would be more appropriate than the current mandate for the use of oxygenates.

On behalf of the city of Santa Monica, I thank you Senator Boxer for the tremendous past support which you have given us in dealing with the MTBE problem. I look forward to further collaboration with you and your staff as we move forward toward comprehensive solutions.

STATEMENT OF CYNTHIA C. DOUGHERTY, DIRECTOR, OFFICE OF GROUND WATER AND DRINKING WATER, ENVIRONMENTAL PROTECTION AGENCY

Thank you for the invitation to appear here today. I am pleased to discuss the activities that EPA is undertaking to address environmental issues associated with methyl tertiary-butyl ether (MTBE).

MTBE has been detected at elevated concentrations in groundwater near leaking fuel tanks throughout California, and this has raised concerns regarding the occurrence of MTBE in drinking water supplies. The Federal Government is addressing questions about MTBE on many fronts, and is working to accurately understand and characterize the scientific and policy issues. With respect to drinking water, this work will substantially improve our knowledge of the occurrence, potential for human exposure, and health effects of MTBE in drinking water sources across the country. We believe the data obtained from these activities should help increase our understanding of MTBE and other potential fuel oxygenates to better inform our decisions. In addition, yesterday EPA made available a Drinking Water Advisory on MTBE to provide guidance and information to States and local communities as they make important water supply and management decisions if MTBE is detected in a drinking water supply.

Clean Air Act

As you know, in the 1990 amendments to the Clean Air Act (CAA), Congress mandated the use of reformulated gasoline (RFG) in those areas of the country with the worst ozone or smog problems. The RFG program, which began January 1, 1995, is currently required in ten areas and voluntarily implemented in another twenty-two (these thirty-two areas are in a total of 18 States and the District of Columbia). As directed in the CAA, RFG must contain a minimum oxygen content of 2 percent by weight, a maximum benzene content of 1 percent, and no lead, manganese, or other heavy metals. In June 1996, California required statewide use of its Phase II RFG, the "cleaner burning gasoline," which has stricter standards than the Federal RFG requirements. RFG accounts for about 30 percent of the gasoline nationwide.

RFG is required to reduce the emissions of both ozone-forming volatile organic compounds (VOCs) and toxic pollutants by 15 percent with no nitrogen oxide (NO_X) increase. The refiners' 1995/96 fuel data submitted to EPA indicate that the emissions benefits exceed the required reductions. EPA's 1996 Air Quality Trends Report showed that various toxic air pollutants, such as benzene, a known carcinogen, declined significantly between 1994 and 1995. Analysis indicates that this progress may be attributable to the use of RFG. Starting in the year 2000, the required emission reductions are substantially greater, at about 27 percent for VOCs, 22 percent for toxics, and 7 percent for NO_X.

Ethanol and MTBE are the primary oxygenates used in the RFG program to meet the oxygen content requirement. MTBE is not subsidized and is used in about 84 percent of RFG supplies because of economic reasons and its blending characteristics. MTBE is also often used in gasoline at lower concentrations as an octane enhancer in place of lead to reduce engine knocking.

On November 21 of this year, Charles Freed, Director of EPA's Fuels and Energy Division, testified before the Assembly Natural Resources Committee of the California legislature on the winter oxygenated gasoline program and its environmental benefits and issues. I would like to repeat his testimony that it is EPA's position that the oxygenated fuels program and the reformulated gasoline program have resulted in large emission reductions, boosted the use of nonpetroleum and renewable fuel components, and improved air quality in our cities.

Research

EPA and other Federal agencies have been conducting research to improve our knowledge of the issues related to MTBE. The White House Office of Science and Technology Policy (OSTP) convened an Interagency Oxygenated Fuels Assessment Steering Committee in May 1995 upon EPA's request. In February 1996, OSTP released its draft assessment of the wintertime oxygenated fuels program which looked at a broad range of issues related to the use of oxygenates in gasoline, including water quality impacts. The National Academy of Sciences (NAS), an independent body of scientists, was then asked by EPA to evaluate and peer review OSTP's draft Oxygenated Fuels Assessment Report. NAS's comments were used by the Committee in developing the final document that was released in June 1997, entitled "Interagency Assessment of Oxygenated Fuels." As a result, this document is a thorough, comprehensive analysis of issues related to oxygenates in gasoline, including health effects, vehicle performance, water quality, and air quality benefits.

The final OSTP report stated that, "MTBE has been detected in 51 public drinking water systems to date based on limited monitoring in 5 States, however, when detected, the concentrations of MTBE were for the most part below the lower limit of the current EPA health advisory. This indicates that the consumption of drinking water was not a major route of exposure for these few systems." The OSTP report also noted that, "Because of the very limited data set for fuel oxygenates in drinking water, it is not possible to describe for the nation MTBE's occurrence in drinking water nor to characterize human exposure from consumption of contaminated drinking water." The OSTP report concluded that more monitoring and research would be needed to better characterize major sources of MTBE to the environment and to enable an exposure assessment for MTBE and drinking water. The report also addressed the comparative risks of MTBE to gasoline, and stated that "the estimated upper-bound inhalation cancer unit risks for MTBE are similar to or slightly less than those for fully vaporized conventional gasoline; substantially less than that for benzene, a constituent of gasoline that is classified as a known human carcinogen; and more than 100 times less than that for 1,3-butadiene, a carcinogenic emission product of incomplete fuel combustion."

EPA's Air program, pursuant to section 211 of the Clean Air Act, recently notified the fuels industry of the health effects testing it is required to perform for conventional and oxygenated gasoline (including MTBE). This exposure assessment and toxicology testing will commence shortly after the public comment period and will result in a greater understanding of the comparative risks associated with inhalation exposures to conventional and oxygenated gasoline fuels. The results of this research effort also may be helpful in characterizing risk in water by extrapolating the data to oral ingestion risk. Once this research is completed, the Agency-directed peer review will determine whether these fuels have been adequately tested or if more research will be required.

EPA is also focusing research on drinking water issues related to MTBE. As a result of the OSTP recommendation for additional information, an Agency-wide task force has been formed to develop a "Research Strategy for Oxygenates in Water." Building upon the findings of the OSTP report, the Strategy will identify key issues and describe a strategy to obtain information to support health risk assessment and risk management in the areas of environmental occurrence, source characterization, transport and transformation, exposure, toxicity, and remediation. The identified research will build a stronger database to better assess the potential health risks related to oxygenates in water, and further our knowledge on occurrence, mitigation and remediation.

On October 7, 1997, EPA convened a day-long meeting of over 50 experts—including representatives from industry, academia, consultants, and other government agencies—to review a draft of the Strategy. The information produced in this workshop is being used to help finalize the research strategy for fuel oxygenates, that

we hope will serve to coordinate efforts by various organizations, public and private, to address the issues related to oxygenates in water. The strategy will go out for public comment in January. I know the research that is being developed in the research partnership between some members of the Association of California Water Agencies (ACWA) and MTBE producers is being coordinated with the research strategy to prevent duplication and ensure effective coverage of needed subjects.

The Resource Conservation and Recovery Act

Underground Storage Tanks Program: In addition to research, EPA has several programs that address MTBE. The primary source of MTBE detections at high concentrations is leaking underground fuel storage tanks, and possibly transmission facilities. About one million underground storage tanks (USTs) are in use in the United States that are subject to regulation under RCRA Subtitle I. About 76,000 of them are in California. Most of them are used for motor vehicle fuels—either by gasoline stations or by non-marketers having on-site refueling facilities for their own car, truck, or bus fleets. States report that USTs are the most common source of groundwater contamination and that petroleum is the most common contaminant.

EPA's ongoing efforts under our Underground Storage Tank (UST) Program are designed to prevent further contamination of water supplies by petroleum, including gasoline containing MTBE. Existing tanks are required to be upgraded, replaced, or closed by December 1998 to meet the spill, overfill, and corrosion requirements of Federal law, and in California are also required to be lined or double-walled. EPA regulations have required leak detection methods to be in place for all USTs since 1993. Both EPA and the States have the authority to enforce these regulations. In addition, EPA's UST Office is working closely with States to assist them in addressing MTBE when petroleum leaks are remediated. The Agency is also coordinating with the U.S. Department of Transportation on its pipeline leak prevention program.

States have the primary responsibility for implementation and enforcement of the UST regulations although EPA also maintains authority to enforce these regulations. EPA recognizes that, because of the size and diversity of the regulated community, State and local governments are in the best position to oversee USTs. Subtitle I of RCRA allows State UST programs approved by EPA to operate in lieu of the Federal program.

EPA has focused on helping State and local governments build programs capable of ensuring that USTs do not threaten human health or the environment. EPA provides financial assistance to States through cooperative agreements, as well as providing technical and regulatory assistance for the purpose of building State programs. For instance, in a joint undertaking in May 1997, States and EPA inspected about 10,000 UST facilities, primarily to check on compliance with release detection requirements that have been in effect since December 1993. State and EPA inspectors found that about 68 percent of UST facilities were in full compliance. In addition, through data collected during this undertaking as well as data that EPA has begun collecting from States, EPA estimates that about half of UST facilities are now in compliance with the 1998 requirements. EPA Regional Offices are working with States to develop State-specific plans for increasing the compliance rate and for taking post-deadline enforcement action. Where States cannot or will not enforce the requirements, EPA can do so. The Agency is developing a plan for Federal action to support and augment State enforcement.

The Santa Monica Enforcement Action: In May 1996, after the City of Santa Monica had learned that its Charnock and Arcadia drinking water wellfields were contaminated with MTBE, the City of Santa Monica wrote to EPA requesting our assistance with addressing this problem. EPA staff attended Task Force meetings organized by the city to learn more about this problem that also was affecting the Southern California Water Company which delivered water to nearby Culver City. By December 1996, the City of Santa Monica's own initial efforts to obtain the cooperation of potentially responsible parties (including issuance of RCRA Section 7002 citizen suit notices) appeared to be unsuccessful. As a result, EPA decided to undertake a 3-month assessment of the contamination problem including the appropriate role for the Federal Government.

In March 1997, after extensive consultation with the Los Angeles Regional Water Quality Control Board and the State Water Resources Control Board, EPA decided that it should play a role in addressing Santa Monica's MTBE contamination problem. EPA agreed to provide technical support and field oversight for the Arcadia wellfield investigation already being conducted by Mobil Oil Company under the supervision of the LA Regional Board. EPA also agreed to conduct a joint enforcement action with the LA Regional Board for the Charnock wellfield contamination.

In April, 1997, EPA and the LA Regional Board entered into a Memorandum of Understanding to define their relative roles and responsibilities with respect to the Arcadia and Charnock investigations. Beginning with this MOU, EPA and the Board ("the agencies") have developed a flexible and effective partnership to jointly address the two sites.

The agencies worked with the city and Southern California Water Company to develop uniform requirements for information submittal on historical fuels management practices and for the conduct of systematic field investigations. These requirements were issued to the potentially responsible parties (PRPs) on June 19, 1997. The agencies held a meeting in Santa Monica on June 26, 1997 to discuss the requirements with the PRPs where about 80 people attended.

Site field work began at some sites in November. The agencies have completed initial reviews of workplans for all of the sites and second reviews are approximately 80 percent complete. The agencies are hopeful that all sites will have approved workplans and begin field work by the end of January 1998. All final investigation reports are expected by early April 1998. The agencies believe that this represents rapid progress in addressing a very complex hydrogeologic problem.

After the PRPs' investigation reports have been reviewed by the agencies, we will notify those PRPs who have been determined to have contributed to the Charnock Sub-Basin MTBE contamination. These notified PRPs will be required, hopefully in a settlement, but if not, through court action, to design and implement remediation which will bring the Charnock Sub-Basin back into beneficial use as a drinking water supply. EPA and the LA Regional Board plan to continue working jointly, in consultation with the impacted parties, to ensure this result.

Some interim remediation has begun at the Arcadia wellfield where a pump and treat system is operating in order to control further migration of contaminated groundwater from the site. Source control and removal is still in progress. To date, approximately 2,000 cubic yards of contaminated soil have been removed from the site.

Safe Drinking Water Act

In addition to authorities under RCRA, EPA is using authorities under the newly reauthorized Safe Drinking Water Act (SDWA) to address MTBE. The Safe Drinking Water Act Amendments of 1996 require EPA to publish a list of contaminants that may require regulation, based on their known or anticipated occurrence in public water systems. The amendments also require EPA periodically to make a determination of whether or not to develop regulations for at least five contaminants from this list (the first deadline for this determination is 2001). After consultation with the scientific community, including EPA's Science Advisory Board, the Office of Water published a draft Contaminant Candidate List for public comment in the Federal Register on October 6, 1997 (62 FR 52194). MTBE is included on this list. If health effects and occurrence information indicates the need, EPA also has authority to issue interim regulations for any contaminant that presents an urgent threat to public health, prior to the statutory deadlines for the determination to regulate or not.

SDWA, as amended, also creates a new source water assessment program. States are required to assess the susceptibilities of each community's drinking water to sources of contamination, including a review of all potential sources of contamination such as underground storage tanks. With the results of these assessments, communities can develop measures to protect their water supply from these sources of contamination. Because these results must be reported to consumers in each community, protection measures can be tailored to address significant local concerns. The source water assessment program builds on the Wellhead Protection Program, which was created in the 1986 SDWA amendments, and is designed to protect ground water sources of drinking water. Forty-seven States and territories have Wellhead Protection Programs.

Occurrence, fate, and transport of MTBE are issues on which it is essential that we improve our current understanding. Several efforts are underway in this area. As you know, although the California Department of Health Services (DHS) advised public drinking water suppliers to monitor their sources of drinking water for MTBE in February 1996, it was not required by State regulation until February 1997. As of August 1997, 428 of 4,418 drinking water suppliers had sampled for MTBE. Fifteen suppliers have reported MTBE detections and 27 or 1.2 percent of the sampled sources detected MTBE. Most of the reported concentrations to date have been below the draft 1992 Health Advisory 20 to 200 micrograms per liter range.

The EPA Office of Water has also entered into a cooperative agreement with the United States Geological Survey (USGS) to conduct an assessment of the occurrence and distribution of MTBE in the 12 mid-Atlantic and Northeastern States. Like

California, these States have used MTBE extensively in the RFG and Oxygenated Fuels programs. This study will supplement the data gathered in California and will indicate whether or not MTBE has entered drinking water distribution systems or affected drinking water sources, and what types of pollutant sources are associated with detections of MTBE. We are preparing to begin data collection in early 1998.

The USGS also is continuing its National Water Quality Assessment (NWQA) program, which includes monitoring for VOCs, including MTBE, in storm water, shallow groundwater, and shallow and deeper ground water in selected areas of the country.

Finally, EPA released a Drinking Water Advisory on MTBE that will assist States and local communities in making important water supply and management decisions if MTBE is detected in a drinking water supply. This advisory is the latest of about 260 advisories issued in the twenty-year history of the advisory program. An advisory is not legally enforceable and is issued as guidance to water utilities and State and local heath officials to provide them with information, when there is no standard, on chemical contaminants that can be present in drinking water.

MTBE is one of the unusual contaminants which appears to cause unpleasant taste and odor responses at concentrations in water below levels at which there is a health effects concern. The Advisory recommends that MTBE be controlled to levels in water that will protect the consumer acceptability of the water resource. The recommended levels will also provide protection of public health.

The Advisory provides an evaluation of current health hazard information and an evaluation of currently available data on taste and odor problems associated with MTBE contamination of water, as the latter affect consumer acceptance of the water resource. It does not recommend either a low-dose oral cancer risk number or a reference dose (estimated no effect dose for noncancer effects) due to certain limitations of available data for quantifying risk. Guidance is given on the concentrations at which taste and odor problems likely would be averted, and how far these are from MTBE concentrations at which toxic effects have been seen in test animals.

The Advisory recommends that keeping levels of contamination in the range of 20 to 40 μg/L or below to protect consumer acceptance of the water resource would be expected to provide a large margin of safety from any potential health effects. Taste and odor values are presented as a range since human responses vary depending upon the sensitivities of the particular individual and the site-specific water quality conditions. These values are provided as guidance recognizing that water suppliers determine the level of treatment required for aesthetics based upon the customers they serve and the particular site-specific water quality conditions.

There are over four to five orders of magnitude between the 20 to 40 μg/L range and concentrations associated with observed cancer and noncancer effects in animals. There is little likelihood that an MTBE concentration of 20 to 40 g/L in drinking water would cause adverse health effects in humans, recognizing that some people may detect the chemical below this range. Concentrations in the range of 20 to 40 μg/L are about 20,000 to 100,000 (or more) times lower than the range of exposure levels in which cancer or noncancer effects were observed in rodent tests. It can be noted that at this range of concentrations, the margins of safety are about 10 to 100 times greater than would be provided by an EPA reference dose (RfD)to protect from noncancer effects. Additionally, they are in the range of margins of safety typically provided by National Primary Drinking Water Standards under the Federal Safe Drinking Water Act to protect people from carcinogenic contaminants.

The Advisory notes that occurrences of ground water contamination observed at or above this 20–40 μg/L taste and odor threshold—that is, contamination at levels which may create consumer acceptability problems for water suppliers—have to date resulted from leaks in petroleum storage tanks or pipelines, not from other sources.

Key research is anticipated to be published in 1998 that will enable EPA to utilize existing data from animal studies conducted by inhalation exposure to estimate human drinking water risk. This will address a major uncertainty and data gap that currently prevents risk estimates to be presented in the Advisory. When such data become available, the Office of Water will publish another Advisory that includes quantitative estimates for health risks.

In summary, EPA is deeply involved in a comprehensive range of activities to gather the best scientific understanding of MTBE we can, as quickly as possible, to enable us to help protect the nation's water supplies in an informed and responsible manner. We believe this approach is faithful to the direction of Congress in the SDWA Amendments of 1996, to base our regulation of drinking water on "the best available, peer-reviewed science." This focused and coordinated effort should assure

you that EPA takes seriously the appearance of MTBE in water supplies, and that we and our partners are undertaking many activities to address concerns.

STATEMENT BY JOHN ZOGORSKI, CHIEF, NATIONAL SYNTHESIS ON VOLATILE ORGANIC COMPOUNDS, NATIONAL WATER-QUALITY ASSESSMENT PROGRAM, U.S. GEOLOGICAL SURVEY, U.S. DEPARTMENT OF THE INTERIOR

Senator Boxer, I appreciate the opportunity to appear before the Senate Committee on Environment and Public Works to testify on the subject of methyl tertiary butyl ether—commonly referred to as MTBE—and water quality. My name is John Zogorski. I'm a hydrologist with the U.S. Geological Survey (USGS). As you may know, the mission of the USGS is to assess the quantity and the quality of the earth resources and to provide information that will assist resource managers and policy makers at the Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission. I am working on the National Water-Quality Assessment Program—often referred to as NAWQA. More specifically, I am responsible for the aspect of the NAWQA Program that is focused on synthesizing information on the occurrence and distribution of volatile organic compounds (VOCs) in ground water and surface water. MTBE is one of about 60 VOCs that we are assessing. The building blocks for the NAWQA assessment are comprehensive water-quality investigations of more than 50 large river basins and aquifers distributed across the United States (Figure 1). The San Joaquin-Tulare, Sacramento, and Santa Anna River basins in California are 3 of the study units that NAWQA is assessing.

In 1995, the NAWQA Program published a report discussing the occurrence of MTBE in shallow ground water in urban and agricultural areas from the first set of 20 study units. Chloroform and MTBE were the two most frequently detected VOCs in samples from about 200 shallow wells in 8 urban areas and about 500 shallow wells in 20 agricultural areas. MTBE was detected in about 25 percent of the urban wells and about 1 percent of the agricultural wells. Concentrations ranged from the detection level of 0.2 micrograms per liter to as high as 23,000 micrograms per liter. MTBE was most frequently detected in shallow ground water in Denver, Colorado and urban areas in New England. In Denver, about 80 percent of the samples from shallow urban wells had detectable concentrations of MTBE and in New England, about 35 percent of the samples from urban wells had detectable concentrations. Only 3 percent of the wells sampled in urban areas had concentrations of MTBE that exceeded 20 micrograms per liter, which is the estimated lower limit of the U.S. Environmental Protection Agency (USEPA) draft drinking water health advisory level (figure 2.).

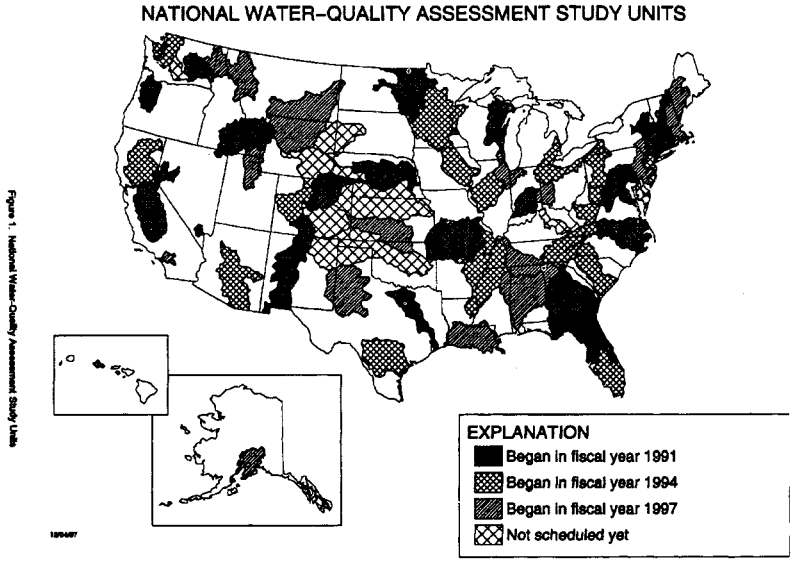

Figure 1. National Water-Quality Assessment Study Units

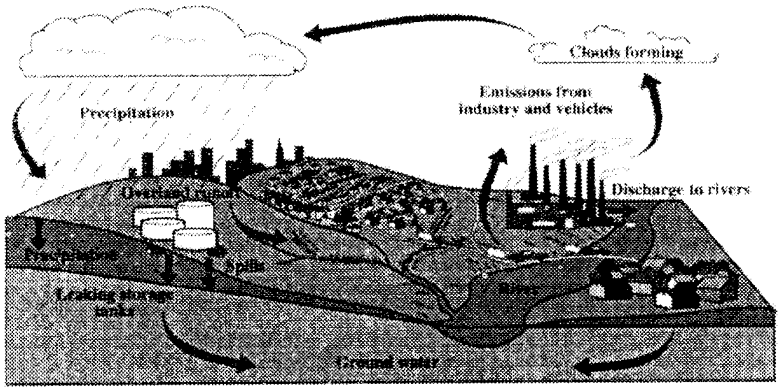

Figure 3. The movement of MTBE in the environment.

I believe my colleagues from the USEPA will more fully discuss what is known about the human and aquatic health effects of MTBE and other fuel oxygenates. The initial sampling did not include information from urban areas in California. An urban ground water study is a component of the Sacramento River basin investigation, however, and our data collection in Sacramento will be completed at the end of this fiscal year.

Last year, at the request of the USEPA and the Office of Science and Technology Policy (OSTP), I co-chaired an interagency panel to summarize what is known and unknown about the water-quality implications associated with the production, distribution, storage, and use of fuel oxygenates and their movement in the hydrologic cycle (figure 3).

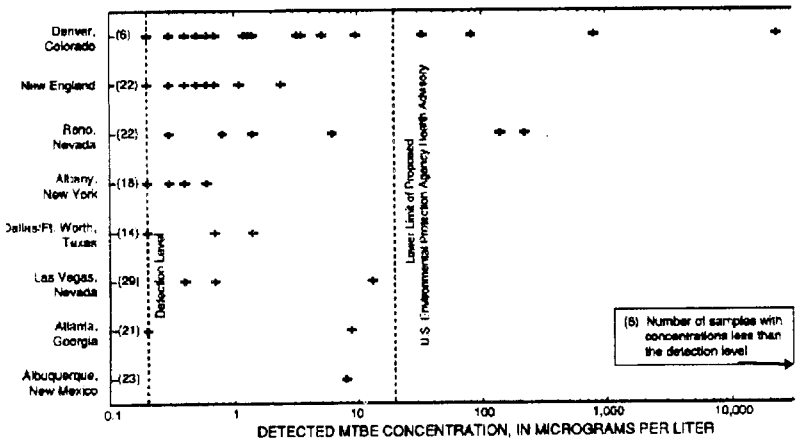

Figure 2. The concentrations of MTBE in each of the eight urban study areas.

The results of our efforts were published as a chapter in a report entitled "Interagency Assessment of Oxygenated Fuels" prepared by the National Science and Technology Council, Committee on Environment and Natural Resources. The chapter summarizes the scientific literature and data on the sources, concentrations, behavior, and the fate of fuel oxygenates in ground water and surface water. We also discussed the implications for drinking water quality and aquatic life and we identified areas where the data are too limited to make definitive statements about the costs, benefits, and risks of using oxygenated gasoline in place of conventional gasoline. Recommendations for further data-base compilation, monitoring, assessment, research and reporting were made that we believe would reduce uncertainties and

allow a more thorough assessment of human exposure, health risks and benefits, and environmental effects.

I'd like to briefly summarize for the committee the major findings, conclusions and recommendations of this interagency assessment that was completed in late 1996:

MTBE is the most commonly used fuel oxygenate. United States production in 1995 was estimated to be about 9 million tons. Essentially all of the MTBE that is produced is used for fuel oxygenation. Ethanol is the second most used oxygenate in gasoline blending. Ethanol production in the United States in 1994 was estimated to be about 4.5 million tons or roughly half the production of MTBE. No data are available to estimate the portion of this production used in gasoline.

Like other hydrocarbon components of gasoline, fuel oxygenates are introduced to the environment during all phases of the petroleum fuel cycle: production, distribution, storage, and use. Releases of gasoline containing oxygenates to the subsurface from, for example, underground storage tanks, pipelines, and refueling facilities provide point sources for entry of oxygenates as well as gasoline hydrocarbons into the hydrologic cycle. Urban and industrial runoff and wastewater discharges also represent potential sources of oxygenates to the environment. In a few instances, such as in Santa Monica, California, high concentrations of MTBE have caused the shutdown of a drinking-water production wells and the source of contamination is believed to be leaking underground gasoline storage tanks.

Exhaust emissions from vehicles and evaporation from gasoline stations and vehicles are sources of MTBE and other oxygenates to the atmosphere. Because of their ability to persist in the atmosphere for days to weeks and because they will, in part, "mix" into water, fuel oxygenates are expected to occur in precipitation in direct proportion to their concentration in air. Hence, fuel oxygenates in the atmosphere provide a non-point, low concentration source to the hydrologic cycle. MTBE is much less biodegradable than ethanol or the aromatic hydrocarbon constituents of gasoline and, therefore, it will persist longer in ground water. MTBE also adsorbs only weakly to soil and aquifer materials. Consequently, MTBE will move with the ground-water flow and migrate further from sources of contamination.

MTBE was detected in 7 percent of 592 storm-water samples in 16 cities surveyed by the USGS between 1991–1995. When detected, concentrations ranged from 0.2 to 8.7 micrograms per liter, with a median of 1.5 micrograms per liter. A seasonal pattern of detections was evident, as most of the detectable concentrations occurred during the winter season. MTBE was detected both in cities using MTBE-oxygenated gasoline to abate carbon monoxide non-attainment and in cities using MTBE-oxygenated gasoline for octane enhancement.

At least one detection of MTBE has occurred in ground water in 14 of 33 States surveyed. MTBE was detected in 5 percent of about 1,500 wells sampled, with most detections occurring at low micrograms per liter concentrations in shallow ground water in urban areas.

Limited monitoring by Federal, State, and local agencies and organizations has shown that drinking water supplied from ground water is a potential route of human exposure to MTBE. As of 1997, MTBE has been detected in 51 public drinking water systems based on limited monitoring in 5 States including New Jersy, Iowa, Colorado, Illinois, and Texas. However, when detected, the concentrations of MTBE were, for the most part, below the lower limit of the current USEPA health advisory. This indicates that the consumption of drinking water was not a major route of exposure for these few systems. Because of the very limited data set for fuel oxygenates in drinking water, it is not possible to describe MTBE's occurrence in drinking water nor to characterize human exposure from consumption of contaminated drinking water for the nation. There is not sufficient data on fuel oxygenates to establish water quality criteria for the protection of aquatic life, however, the petroleum industry is sponsoring research to complete needed studies.

The presence of MTBE and other alkyl ether oxygenates in ground water does not prevent the clean up of gasoline releases: however, the cost of remediation involving MTBE will be higher than for releases of conventional gasoline. Also, the use of natural bioremediation to clean up gasoline releases containing MTBE may be limited because of the difficulty with which MTBE is biodegraded.

The OSTP chapter on fuel oxygenates and water quality includes three broad recommendations.

First, more complete monitoring data and other information is needed to:

A. Identify and characterize major sources of MTBE to the environment;

B. Characterize the relation between use of MTBE (and other alkyl ether oxygenates) in gasoline and water quality; and

C. Enable an exposure assessment for MTBE in drinking water.

Completing the exposure assessment for MTBE in drinking water should be given high priority. Monitoring of MTBE in drinking water for this purpose should ini-

tially be targeted to high MTBE use areas, and to those environmental settings that are otherwise thought to be most susceptible to contamination.

Second, additional studies are needed to expand current understanding of the environmental behavior and fate of MTBE and similar oxygenates. For example, these studies are needed to help determine the significance of the urban atmosphere and land surface as non-point sources of contamination to surface and ground water, and to identify environmental settings where MTBE will be of concern.

Finally, studies of the aquatic toxicity of MTBE and similar oxygenates are needed for a broad range of aquatic animals and plants indigenous to surface waters to define the extent of any threat and to form the basis of Federal water-quality criteria, if warranted.

Again, I appreciate the opportunity to testify at this hearing. I'd be happy to try to address any questions of the committee.

STATEMENT OF PETER M. ROONEY, SECRETARY FOR ENVIRONMENTAL PROTECTION, CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

Good morning, Senator Boxer. I am Peter Rooney, Secretary for the California Environmental Protection Agency. I would like to start by thanking you for the opportunity to address you today on the issue of MTBE, its use as a gasoline additive, and the potential impacts of MTBE on human health and the environment. As you know, these are issues Cal/EPA, the California legislature, and other interested parties have been discussing at length during this last year, discussions I am sure will continue throughout this legislative session.

I understand you wish to limit today's conversation to the impacts of MTBE on water, but it is impossible to talk about this issue without first discussing why it is being used as a gasoline additive.

The Introduction of Cleaner Burning Gasoline

As I'm sure you know, Senator, California has one of the greatest air quality challenges in the nation. At some time during the year, 90 percent of California residents breathe air that does not meet the current Federal health-based air quality standards. Five of the seven air basins with ilk greatest air quality difficulties in the nation can be found here.

California has, however, through innovative and technology-based strategies, realized great improvements in its air quality. 1996 proved to be the cleanest "ozone season" on record for the South Coast Air Basin, the Los Angeles region, and for San Diego. (1997 is even better, but 1996 may be a more appropriate benchmark to use because of the influence meteorology had on this year's air quality.) Undoubtedly, one of the chief reasons for that improved air quality in 1996 was the introduction of California's Cleaner Burning Gasoline onto the market, in most cases, ahead of schedule. The improvement in air quality is all the more remarkable because it came at a time when the California economy was truly in a state of full recovery—when vehicle trips were increasing and, coincidentally, speed limits were being raised.

The success of the California Cleaner Burning Gasoline program is unprecedented. Up to 300 tons per day in ozone-forming precursors are no longer being emitted by the California light-duty vehicle fleet. Public exposure to known, potent human carcinogens has been reduced by 30–40 percent; ambient levels of benzene have been reduced by 50 percent. That benefit is equivalent to 3.5 million vehicles no longer being driven on California roadways.

Why is MTBE a Part of the Cleaner Burning Gasoline?

The most persistent concerns about Cleaner Burning Gasoline relate to die use of MTBE (methyl tertiary butyl ether)—a gasoline additive. Those concerns center around MTBE's potential impact to human health and the environment. MTBE is an oxygenate—a compound that increases the oxygen content of gasoline. Its primary purpose is to allow gasoline to burn more completely and to reduce Carbon Monoxide emissions. It is the oxygenate of choice in California—and I strongly emphasize the word choice.

Despite the best efforts of the California Environmental Protection Agency to clearly articulate the facts surrounding State policy, State regulation, and the state of the science on MTBE, the issue has been confused and confusing. So, in the interest of informing the committee, a brief overview is in order.

What Are Oxygenates?

First and foremost, oxygenates are a required additive in California's Cleaner Burning Gasoline year-round because it is required by Federal law—(the Federal

Clean Air Act). Oxygenates are a class of compounds that are blended with gasoline to increase its oxygen content.

Oxygenates are grouped into two different classes; ethers and alcohols. Recently, there have been three different ethers in use throughout the United States. Currently, the lost widely used is methyl tertiary butyl ether (MTBE), followed by tertiary amyl methyl ether (TAME) and occasionally some small amounts of ethyl tertiary butyl ether (ETBE). Ethanol is the only alcohol currently in use as an oxygenate, although to my knowledge, it is not being used in California at this time.

Oxygenates are blended with reformulated gasoline to help dilute the volumes of benzene, sulfur, aromatics, olefins, and other undesirable compounds. During the winter months, areas throughout the United States that are in violation of carbon monoxide standards use oxygenates to help reduce tailpipe CO emissions.

MTBE Mandate

No Federal law or regulation, and no State law or regulation mandates the use of MTBE. In fact, California's Cleaner Burning Gasoline regulations provide the refining industry with the ultimate flexibility. As long as the performance standard is met, as long as the emission reductions are realized, California regulation allows Cleaner Burning Gasoline to be made without any oxygenate at all, except in the wintertime months, as explained above.

Federal law preempts that flexibility. That's why the California Air Resources Board, Cal/EPA and Governor Pete Wilson's Administration has been on record for the past 2 years in support of efforts by a fonder member of the California Air Resources Board, Representative Brian Bilbray (HR 630 of 1997 and HR 3518 of 1996), that would remove the year-round oxygen ate mandate from the Federal Clean Air Act, at least with respect to California. I aid also pleased to note that Senator Feinstein has recently announced that she will introduce a companion bill in the Senate this January.

California's state-of-the-art predictive model, indicates that gasoline can be made without any oxygenate and that Cleaner Burning Gasoline made without an oxygenate will still yield equivalent emission reductions, and several companies have recently indicated they would do so if Federal law was changed to mimic California's for a flexible, performance based approach.

MTBE in the Water

You have specifically expressed an interest in the impact of MTBE in the waters of California. The Department of Health Services' Public Drinking Water Branch is addressing issues associated with the presence of detectable levels of MTBE in drinking water supplies in California—and has increased monitoring which was initiated in February of this year. Dr. David Spath from the Department of Health Services is here with me, and will address that issue more fully.

In 1983, the California legislature designated the State Water Resources Control Board (State Water Board) as the lead agency for administration of State and Federal underground storage tank (UST) laws. The State Water Board administers the UST Program as well as the UST Cleanup Fund. The UST Program includes both leak prevention and cleanup when leaks occur. I will discuss each of these programs as well as current State Water Board activities related to MTBE.

UST Leak Prevention

California State law, paralleling USEPA regulations, provided a 10-year compliance period for all related USTs to be removed, upgraded or replaced in accordance with State and Federal standards by December 22, 1998 (note: smaller USTs, defined as those holding less than 1,100 gallons, are not regulated by either State or Federal law).

In 1983, there were approximately 155,000 operating USTs at 60,000 facilities. There are now approximately 65,000 operating USTs located at 25,000 facilities. Aid estimated)3 000 of dose USTs, or 43 percent, still need to be removed, upgraded or replaced. This compares favorably with USEPA estimates which range from 45 to 60 percent of USTs nationwide which are still out of compliance.

While the State Water Board has adopted regulations pertaining to UST leak prevention, over 100 local California agencies actually implement flee program. These local agencies are responsible for issuing operating pen-its for all USTs in California.

Both the State Water Board and local agencies have pursued aggressive efforts to ensure that the 1998 State and Federal upgrade deadline is met. Outreach efforts have included public workshops held throughout the State for UST owners, articles in industry newsletters, direct mailings to UST owners, newspaper advertisement, and site visits by local agency field inspectors.

In addition, the State Water Board has met with each State Agency that operates USTs and has obtained a commitment from each of those agencies that the 1998 deadline will be met. We are hopeful tat all Federal agencies will match our commitment, but to date we have not received these assurances.

To further ensure compliance with the 1998 UST upgrade deadline, the Administration proposed and Governor Wilson signed SB 1491, authored by Assemblyman Cunneen. This law will prohibit the delivery of fuel to USTs which do not comply with upgrade standards after January 1, 1999. The State Water Board is in the process of preparing certificates of compliance which will be posted in a visible location at each UST facility. This bill, sponsored by the Wilson Administration and supported by industry, underscores our commitment to prevent future leaks from USTs.

The cost to tank owners to comply with the 1998 deadline varies considerably depending on whether the UST is upgraded by installing what is defined as a bladder or an epoxy lining or replaced with a double wall tank and double wall piping. Thus, for a three tank facility, the costs may range from $50,000 to $200,000.

In order to assist UST owners in financing the costs of upgrades, the California Trade and Commerce Agency offers low interest loans. To date, the UST Cleanup Fund has provided over $42 million for this loan program. We have also supported legislation to increase funding for the loan program. However, we recognize that the loan program will not cover the needs of the many UST owners who will need financing in the near tend. Many UST owners will have to obtain private sector financing for facility upgrades.

Finally, to ensure that the 1998 State and Federal standards for USTs are effective in preventing future leaks, Governor Wilson has directed die State Water Board to convene an advisory panel of knowledgeable people, including representatives from industry, local governments and water supply agencies. The advisory panel will review existing databases of UST contamination sites to determine if there is a leak history associated with UST systems that already meet die 1998 Federal and State standards. If there is such a history, the panel will identify appropriate measures that would assure the prevention and detection of releases from retail marketing facilities.

UST Cleanup Efforts

The cleanup of leaking USTs involves a coordinated effort between the State Water Board, nine Regional Water Quality Control Boards, 20 counties under contract with the State Water Board, and a number of other local agencies, all of whom conduct regulatory cleanup oversight. The total annual budget for regulatory cleanup oversight is approximately $20 million.

As of October 1997 and since the UST program's inception in 1983, a total of 31,704 sites have been identified as having leaking USTs. Tanks have been removed and appropriate cleanup measures have been completed at 15,328 of those sites. The 48 percent closure rate compares with a USEPA reported national average of 49 percent.

The State Water Board has adopted regulations related to required cleanup of leaking UST sites and has provided training and technical assistance to local regulatory staff. Regional Water Quality Control Boards and local agencies oversee approximately 5,000 and 11,000 site cleanups, respectively.

UST Cleanup Fund

The UST Cleanup Fund (Fund) was established in February 1991 to achieve two goals. First, to provide affordable environmental impairment insurance to eligible UST owners and operators enabling deem to meet Federal and State financing responsibility requirements, and second, to provide financial assistance for eligible cleanup costs and damages awarded to third parties injured by petroleum releases. On June 9, 1993, the USEPA approved California's Fund as a mechanism for meeting the Federal financial responsibility requirements for USTs containing petroleum.

Existing law requires every owner of a regulated petroleum underground storage tank to pay a per-gallon storage fee to the Fund. The fee began on January 1, 1991 at six mills ($0.006) per gallon and has been gradually increased to 12 mills ($0.012). The fee collection is scheduled to end on January 1,2005. The Fund's program will then begin to wind down as funds are depleted. (As of October 1997, the Fund had received over $700 million.)

To be eligible to file a claim with the Fund, the claimant must be a current or past owner or operator of the UST from which an unauthorized release of petroleum has occurred, and must be required by the appropriate regulatory agency to under-

take cleanup action. Other eligibility conditions include compliance with applicable State UST permitting requirements and regulatory agency cleanup orders.

The maximum reimbursement per site is $1 million, less the deductible. The deductible varies from $0 to $20,000 depending upon the claimant's priority classification.

Statute governing the Fund sets forth a claim priority system which is based on claimant characteristics. The highest priority, Class A, is given to residential tank owners; the second priority, Class B, is given to small California businesses, governmental agencies and nonprofit organizations with gross receipts below a specified maximum; the third priority, Class C, is given to California businesses, governmental agencies and nonprofit organizations having fewer than 500 employees; and the fourth priority, Class D, is given to all other claimants.

Under the statute, the Priority List must be updated at least once a year to include new claims. Since Fall 1993, the list has been updated monthly. Claims from previous updates retain their relative ranking within their priority class with new claims ranked in their appropriate class below those carried over from the previous list. New claims in a higher priority class must be processed before older claims in a lower priority class.

As of November 30, 1997, the Fund had received 352 Priority "A" applications; 4,362 Priority "B" applications; 2,096 Priority "C" applications; and 5,977 Priority "D" applications, for a total of 12,751 applications.

When a claim is activated from the Priority List, the eligibility requirements are verified with the appropriate regulatory agency, and a Letter of Commitment (LOC) is issued. The LOC is the mechanism the program uses to award or encumber funds for reimbursements of cleanup costs. As of November 30, 1997, the Fund had issued 5,252 LOCs in the amount of $546 million. These include 221 "A" claimants; 2,851 "B" claimants; 1,819 "C" claimants; and 361 "D" claimants. The average costs of cleanup paid by the Fund has been $150,000.

In addition to reimbursing claimants for corrective action costs, the Fund provides money to the Regional Water Quality Control Boards (RWQCBs) and local regulatory agencies to abate emergency situations or cleanup sites which are posing a significant threat to human health, safety, and the environment. The Petroleum Underground Storage Tank Emergency, Abandoned, Recalcitrant (EAR) Account was established within the Fund to take corrective action at petroleum UST sites that have had an unauthorized release and that require either (l) immediate action to protect human health, safety and the environment (emergency or prompt action sites); or (2) where a responsible party cannot be identified or located (abandoned sites); or (3) the responsible party is either unable or unwilling to take the required corrective action (recalcitrant sites). All costs incurred are subject to cost recovery from the responsible party. The State Water Board manages the EAR Account which is funded by aid annual Budget Act appropriation of $5 million from the Fund.

The Commingled Plume Account was created within the Fund by the legislature in 1996 to encourage responsible parties with commingled plumes to coordinate their cleanup efforts, avoid litigation, more rapidly address required cleanups, and significantly reduce the costs of cleanup. A Commingled Plume is defined as the condition that exists when groundwater contaminated with petroleum from two or more discrete unauthorized releases have mixed or encroached upon one another to the extent that the cleanup action performed on one plume will necessarily affect the other. Commingled plume sites represent a special problem to California's groundwater protection efforts because they often represent more serious water quality impacts, involve parties float disagree as to liability, and include cleanups which continue to be stalled or handled in a piecemeal, haphazard and expensive manner. Unless corrective action is performed in a coordinated manner, cleanup of commingled plumes could be ineffective.

MTBE related actions

In the spring of 1995, the U.S. Geological Survey reported findings of MTBE in shallow groundwater in the Denver area. As a result, our State Water Board asked the oil industry to sample monitoring wells at industry-owned leaking UST sites for MTBE. The results from that sampling efforts showed that most of these sites had detectable levels of MTBE in shallow groundwater. These results were found at about the same time the finding of high levels of MTBE in public drinking water wells in the City of Santa Monica. In the spring of 1996, the State Water Board requested all regulatory agencies involved in leaking UST cleanup oversight to add MTBE to routine monitoring well analyses. In addition, the State Water Board, with funding from the U.S. Department of Energy and the Western States Petroleum Association, contracted with the Lawrence Livermore National Laboratory to conduct

a study of the environmental fate of MTBE in groundwater. The results of the Lawrence Livermore study are expected in March 1998.

Thus far we know that MTBE, like the other three ether compounds used as oxygenate additives to gasoline, is reasonably soluble in water and resistant to biodegradation. As a result, once in groundwater, MTBE is difficult to remediate other than pumping and treating the affected groundwater. Clearly, additional research is needed in the area of treatability. Additional partnerships between the State and Federal Government, as well scientific, petrochemical and water industries are needed to develop faster and more cost efficient methods for remediation contamination.

During the 1997 session, the California legislature passed several bills related to MTBE, in addition to AB 1491 (discussed above), all of which were signed by Governor Wilson. The State Water Board has a number of responsibilities arising from these bills. SB 521 authored by Senator Mountjoy requires that all leaking UST sites be sampled for MTBE prior to the issuance of a regulatory closure letter following satisfactory cleanup. This requirement is consistent with the earlier State Water Board request of regulatory agencies to require analysis of MTBE. AB 592, authored by Assembly Member Kuehl, and SB 1189, authored by Senator Hayden, contain a number of MTBE related provisions including requiring Regional 'Water Quality Control Boards to report new discoveries of MTBE to water supply agencies on a quarterly basis and setting aside $5 million per year from the Fund for an alternative water supply or treatment for MTBE affected drinking water wells when requested by a water supply agency. Finally, AB 521 and SB 1189 require the State Water Board to conduct a pilot study in the Santa Clara Valley and Santa Monica areas to develop a geographical intonation system database of existing and potential sources of MTBE and existing public water supply wells. It is anticipated that once developed and accessible electronically, water supply and regulatory agencies will be able to better assess the potential risks to drinking water wells and surrounding groundwater aid take appropriate or preventative actions. The GIS mapping pilot study will be completed in June 1999. To ensure that possible human and environmental health issues were addressed as comprehensively as possible, in addition to signing these measures, the Governor specifically:

- Directed the State Water Board to determine if there is a leak history associated with tanks that have been upgraded, and if so, to determine what steps should be taken to avoid additional releases;
- Directed the State Water Board to evaluate refueling facilities and practices at marinas, as discussed above;
- Directed the California Energy Commission to conduct an evaluation of MTBE and alternative oxygenates (discussed further below).

Potential Impacts of Banning MTBE

The California Energy Commission (Commission) is currently in the process of conducting a detailed evaluation of alternative gasoline additive supplies that could be used in lieu of MTBE. This study will include potential costs or savings to the public of the various alternatives, the present and future availability of these alternatives and the minimum time frames within which these alternatives could be undertaken without resulting in significant disruptions of California's gasoline supply.

Preliminary estimates indicate that the short-tend impact of banning MTBE on reformulated gasoline production capability for California refineries would be significant. While only 11 percent of reformulated gasoline by volume, MTBE helps achieve compliance by its mixing with less desirable compounds in finished gasoline. With an immediate ban on MTBE, additional gasoline components would have to be removed until the remaining finished gasoline is in compliance, resulting in a decrease of the production of gasoline in the range of 15 to 40 percent by volume. It is not unreasonable to believe that the resulting price spikes and probable spot shortages would have a dramatic impact on California consumers and the State's economy.

The Commission has developed a work plan that will quantify various scenarios of reduced uses of MTBE and replacement with other oxygenates; changes in Federal mandates; and increased reliance on gasoline or blending components produced at refineries outside California.

The Commission's study will develop an alternative oxygenates implementation strategy for California based on each feasible oxygenate, its availability and cost in the intermediate and long trend. The Commission will examine complete substitution of MTBE by ETOH, TBA, ETBE; a case in which oxygenates may be combined (to increase available total supplies of oxygenates); cases which assume changes in Federal legislation; and a case which examines the impact on California

if there is a national movement to ban MTBE. All totaled, 78 different scenarios will be quantified.

The Commission plans to report the supply and price implications for each scenario in two distinct time periods: intermediate-term, and long-term. The near-term period will not be included in the refinery modeling runs but will be examined to determine what limiting factors could interfere with a smooth transition to an alternate oxygenate.

In addition, the time frame and cost to upgrade California's distribution terminals to make them compatible with the alternative oxygenate are being studied and the marine infrastructure will be examined to determine what constraints to moving additional refined products though the system may exist.

Conclusion

Under California regulations, die choice is left to refiners; there is no regulatory impediment to produce Cleaner Burning Gasoline using any oxygenate of choice, or no oxygenate at all. It is the Federal Clean Air Act that explicitly requires that reformulated gasoline in specified areas contain at least 2 percent oxygenate by weight in gasoline year-round.

The clear and consistent message we would like the committee to hear is California's support aid desire for California fuel regulations to be the controlling rules in California. California views efforts like HR 630 as a prelude to further flexibility, not further restrictions.

Cal/EPA aid its sister agencies are moving aggressively to address public concerns about the impact of MTBE and its impact on human health and the environment. We have taken, and will continue to take, swift action to eliminate contamination from any source. Just this last year, we have taken steps to expedite the UST program; enacted a ban on placing fuel into tanks that fail to comply with the Federal regulations initiated actions to update databases to include more accurate information about leaking tanks and pipelines, particularly with regard to their proximity to drinking water sources. We will respond where contamination exists, as we did in the City of Santa Monica.

Cal/EPA is working closely with the Department of Health Services to establish primary and secondary drinking water standards for MTBE, and will expedite review of all health-required actions.

Your staff has specifically asked me to suggest what the Federal Government could do to assist in our efforts. The problem we are discussing here today is yet another example of what can happen when the Federal Government tells States not just what to do, but how to do it. Do not mandate technology. Set standards, hold us to them, but allow us to determine how best to meet them—in this case, through California's far stricter reformulated gasoline requirements that build in flexibility for producers.

STATEMENT OF DAVID SPATH, CHIEF, DIVISION OF DRINKING WATER AND ENVIRONMENTAL MANAGEMENT, CALIFORNIA DEPARTMENT OF HEALTH SERVICE

My name is David Spath. I am the Chief of the Division of Drinking Water and Environmental Management with the Department of Health Services. The Department is responsible for regulating public water systems in California.

I appreciate the opportunity to come before you and discuss the Department's efforts in determining the extent of MTBE contamination of drinking water sources as well as our work toward establishing primary and secondary drinking water standards for the chemical.

The first finding of MTBE in a drinking water source in California occurred in 1990. MTBE was detected in Lobos Creek, which was used by the Presidio of San Francisco as a drinking water source. The chemical was also found in two shallow test wells being developed by the Presidio. These wells were never completed. The source of the MTBE was concluded to be surface runoff from surrounding residential and commercial areas. As a result of these findings. the Department established a 35 parts per billion (ppb) drinking water Action Level for MTBE.

In February 1996, after information in the scientific literature suggested that MTBE may be a potentially significant threat to contaminate groundwater, particularly from leaking underground storage tanks. the Department issued an alert to public water systems recommending that they undertake voluntary monitoring of MTBE in their sources. We also notified public water systems of our intent to adopt a regulation identifying MTBE as an unregulated chemical for which monitoring would be required.

On February 13, 1997, the Department adopted an unregulated chemical monitoring regulation for MTBE. The regulation affects more than 4,400 water systems and approximately 11,000 drinking water sources that include both surface water and groundwater. To date, 479 water systems have reported monitoring results to us. The number of sources sampled is 2,442. The results indicate that 17 systems have detected MTBE in a total of 27 sources. Of those 27 sources, 15 are groundwater sources and 12 are surface water sources. Two water systems have reported sources with levels above the State Action Level of 35 ppb. They include the City of Santa Monica and California Water Service Company in Marysville. In each case the source of water was groundwater. All of the monitoring results that I have cited are available to the public through our Internet site (http://www.dhs.cahwnet.gov/prevsrv/ddwem/index.htm) and are undated monthly.

In addition to overseeing these monitoring activities, the Department is in the process of implementing recently adopted State labs (Senate Bill 1189 (Hayden) and Assembly Bill 592 (Kuehl)), which require the Department to adopt primary and secondary drinking water standards for MTBE. Adoption of the secondary standard is required by July 1998, while the primary standard is required to be adopted by July 1999.

Secondary standards are intended to present aesthetic degradation of drinking water. In the case of MTBE. the focus is on the potential taste and odor problems that the chemical can cause. Unlike Federal secondary standards which are only advisory, California law mandates that the Department enforce State secondary standards. Therefore, public water systems will be required to comply with the MTBE secondary standard.

The secondary standard for MTBE will be based on data from experiments that have been performed by researchers, using panels of subjects who were exposed to varying concentrations of MTBE in water to determine the levels at which it could be smelled or tasted. Recent studies indicated that MTBE exhibits an odor that could be sensed by some panelists at concentrations ranging as low as 2.5 ppb to 21 ppb. These studies also indicated that panelists could taste MTBE at levels ranging from 2 ppb to 40 ppb. The Department has drafted a proposed regulation which would establish a secondary standard for MTBE at 5 ppb. The draft regulation is undergoing administrative review. We expect to have the proposed regulation available for public comment in early 1998.

With regard to the primary drinking water standard, as I previously indicated, the Department currently uses an Action Level for MTBE of 35 ppb in drinking water to protect against adverse health effects. This level is based on non-carcinogenic effects of MTBE in laboratory animals, with a large uncertainty factor that provides an added margin of safety for drinking water. Although animal studies suggest that MTBE may be a weak carcinogen when inhaled, it is not clear if MTBE has similar effects when ingested. This issue is still being studied.

However, even if MTBE is determined to be a weak carcinogen through all routes of exposure, the secondary standard of 5 ppb that the Department is proposing should be sufficient to provide an adequate margin of protection from any potential health concerns.

Along with a strong drinking water regulatory program, the Department also recognizes the need to protect sources of drinking water. Pursuant to the 1996 Federal Safe Drinking Water Act Amendments and recently enacted State law (Senate Bill 1307 (Costa)), the Department, in coordination with Federal, State, and local agencies, is developing a Drinking Water Source Assessment and Protection Program that is designed to assess the vulnerability of drinking water sources to contamination from chemicals such as MTBE and to develop strategies to protect these sources from future contamination. Depending on the States ability to match Federal funding for this program, the Department expects to complete the program plan and submit it to the U.S. Environmental Protection Agency for review and approval by mid-1998. Once the program is initiated we anticipate that, as envisioned by the Federal and State laws, local partnerships between water systems, local government, private industry and the public will be developed to implement voluntary drinking water source water protection measures that will support existing State and Federal source water protection activities.

That concludes my presentation. Thank you again for the opportunity to present our testimony on this important issue.

STATEMENT OF STEPHEN K. HALL, EXECUTIVE DIRECTOR, ASSOCIATION OF CALIFORNIA WATER AGENCIES (ACWA)

Senator Boxer and members of the committee, thank you for providing me an opportunity to submit this statement on behalf of the Association of California Water Agencies (ACWA) regarding methyl tertiary butyl ether (MTBE) and its impact on California water suppliers.

ACWA's 437 public water agency members collectively manage and deliver 90 percent of the urban and agricultural water used in the State. Over 30 million Californians rely on ACWA members to provide a safe and reliable supply of drinking water to their homes, schools and businesses. Every time they turn on the tap, they are trusting our members to provide an adequate supply of healthful water at a cost they can afford.

Public water agencies have worked hard to earn and maintain that trust. In fact, our members believe that consumers should never have to think twice about the quality of their drinking water.

The job our members do has never been easy, given California's unpredictable weather, its complicated distribution system, and its ever-growing and conflicting demands for water. But the emergence of MTBE is presenting a new and ominous challenge that water agencies fear will make their job even more difficult.

Though the subjects of gasoline additives and air quality regulations may be unfamiliar terrain for water agencies, ACWA members have a compelling interest in decisions regarding the continued use of MTBE and other oxygenates in gasoline. The potential for widespread drinking water contamination and the tremendous treatment costs involved demand that water utilities weigh in to ensure that water supply impacts receive due attention and consideration in the MTBE debate.

ACWA members believe failure to adequately study and consider MTBE's impact on water resources before it was approved for use is the direct cause of the problems we face today.

This testimony will describe the scope of the problem from the perspective of water utilities, highlight our primary concerns, identify some preliminary estimates for cleanup costs, and recommend several actions we believe are needed to protect water supplies and drinking water consumers from the impacts of MTBE use.

Scope of the Problem

Monitoring data compiled to date by the California Department of Health Services (DHS) indicates that MTBE is indeed finding its way into the State's water sources. Data collected through November 1997 shows that 29 water sources sampled had detectable levels of MTBE. Five of the 29 were above California's current action level of 35 parts per billion; 12 were above 5 ppb, the level at which DHS believes consumers can smell or taste MTBE in water. It must be noted, however, that MTBE detections are under-represented in the DHS data, particularly with respect to surface water. The data reflects sampling results for only 22 percent of the State's 11,000 water sources, and does not include testing done by water agencies over and above the State's monitoring requirement.

MTBE typically enters groundwater as a result of leaking underground storage tanks or pipelines, or as a result of a spill. Because it is highly soluble in water and is not easily biodegraded, it enters groundwater basins faster than other components of gasoline and is much more difficult to remove once it is there.

To understand what this means for water utilities and their customers, several points must be made about the importance of groundwater resources in California. In a typical year, groundwater accounts for about 40 percent of the State's total water use. In drought years, California relies on groundwater for up to 60 percent of its needs. Many communities, particularly in the Central Valley, coastal regions and deserts, depend on groundwater exclusively for their drinking water needs. Most of the groundwater supplied to Californians today is served just as it comes out of the ground and requires no treatment.

In Santa Monica, MTBE contamination of groundwater at levels of up to 500 ppb caused the city to lose 80 percent of its local water supply. Santa Monica is now forced to buy alternative water supplies at a cost of over $3 million per year. Elsewhere, MTBE is constraining the operations of public water systems. South Lake Tahoe Public Utility District, which has detected MTBE in two groundwater wells, has been forced to shut down two unaffected wells to try to prevent further travel of the MTBE plume in its main aquifer.

MTBE is also being detected in lakes and reservoirs where gasoline-burning recreational vehicles such as jet skis and power boats are used. Preliminary data from a statewide survey of surface water sources coordinated by ACWA during last summer's boating season shows that some MTBE is being detected on the surface of res-

ervoirs and near boat landings and at water intakes. In many cases, MTBE levels are near or slightly above the 5 ppb level that DHS is expected to propose as a secondary (consumer acceptance) standard for MTBE early next year. A report on the survey is due to be completed in early 1998.

Water Utility Concerns

Though some call MTBE the most studied component of gasoline, little definitive data is available on how ingestion of MTBE in drinking water affects human health. The U.S. Environmental Protection Agency (EPA) is expected to issue a revised lifetime health advisory level for MTBE in drinking water of 20 ppb to 40 ppb before the year's end. The California Office of Environmental Health Hazard Assessment (OEHHA) is also evaluating human health risks and is expected to make a recommendation in 1998. The health risk assessments of both EPA and OEHHA are important because they will drive the primary (health-based) drinking water standard that California is required to establish by July 1, 1999. Water utilities have been required to monitor for MTBE since February 1997.

To date, water agencies have been frustrated by the apparent emphasis EPA and California's own Environmental Protection Agency (Cal/EPA) have placed on the air quality benefits of MTBE. Their consistent focus on achieving clean air goals—even at the expense of drinking water quality—has contributed to what many water agencies see as a downplaying of water supply impacts and an unjustified tradeoff between air and water quality protection. While the two agencies have struggled with their own internal debates over MTBE, precious time has been lost that could have been better spent addressing health effects and treatment research needs.

Regardless of what is eventually learned from health effects research, water utilities already know that MTBE fouls the taste and odor of drinking water at relatively low levels. Initial studies by ACWA member agencies and others show that consumers can detect it in drinking water at levels as low as 2.5 ppb. Many describe it as reminiscent of turpentine. With such a low taste and odor threshold, MTBE contamination will render drinking water unacceptable at levels much lower than California's current action level and the heath advisory limit EPA is expected to propose.

Even as regulations are being developed and proposed, water utilities are fielding a growing number of calls from consumers who are concerned about MTBE contamination and the safety of their drinking water. Water agencies take these calls very seriously, and are extremely concerned that ongoing detection of MTBE in drinking water sources around the State will cause consumers to lose confidence in the safety of their local water supplies. The extremely low taste and odor threshold of MTBE only serves to heighten that concern. In many respects, once consumers believe that they can taste or smell MTBE in their drinking water, that water is effectively lost and no amount of treatment or health effects data can restore it.

Though the vast majority of California's water supplies have not been compromised by MTBE to date, any erosion of public confidence is too high a price to pay for a problem the water supply community did not create. Nonetheless, ACWA members will continue to assure their customers that the water delivered to their taps is safe and will further engage in activities on a number of fronts to address MTBE.

Water agencies are tremendously concerned about the cost of treating and cleaning up MTBE in drinking water. Most feel strongly that water utilities and their customers should not be forced to shoulder the high cost of removing this contaminant or purchasing alternative drinking water supplies. There is also concern that too little is known about the best treatment options for removing MTBE from drinking water.

Even if treatment questions were to be resolved tomorrow, ACWA members believe there is not enough being done to protect water sources from the threat of MTBE contamination. Though treatment technology is needed now in Santa Monica and will soon be needed in other communities, in many respects it is too little too late. More must be done to prevent MTBE from reaching groundwater and surface water sources in the first place.

If nothing else, the current MTBE problem has exposed tremendous gaps in our collective knowledge of leaking underground fuel storage tanks, oil pipeline spill detection, refueling practices at retail gas stations and marinas, and the impacts of motorized watercraft on reservoirs. State officials believe there are more than 31,000 leaking underground tanks in California, and one can only assume there are hundreds more that have yet to be identified. Though the State Water Resources Control Board is mounting a major effort to upgrade and replace old tanks with new, double-walled models, to date only 55 percent of the tanks have been upgraded to the new standard. About 30,000 tanks have yet to be upgraded or replaced. Legis-

lation signed this year will prohibit delivery of fuel to tanks that have not been upgraded by January 1999, but ACWA members remain concerned that tanks and refueling practices associated with them will continue to pose a threat to water sources—especially since releases of MTBE are being detected at tank sites that have already been upgraded.

There are also concerns that high-pressure pipelines that carry fuel into and across the State present a significant risk not only to important water sources, but also to treated water distribution lines. In Placer County, for example, there have been two leaks involving pressurized oil pipelines in the past 18 months resulting in contamination by MTBE of water transmission lines carrying treated water to homes. More information is needed to assess this threat of contamination and develop notification and prevention strategies.

It's clear that we will never fully address the MTBE problem until decisive action is taken to protect drinking water sources through such means as removing MTBE from gasoline, improving the way gasoline is handled and stored, and minimizing MTBE releases from motorized watercraft with two-cycle engines.

Water Community Response to the Problem

Even though this is clearly a situation water agencies did not create, ACWA and its members are working proactively to address MTBE rather than pointing fingers. As we have previously done on water quality issues such as arsenic and radon, ACWA is taking a leadership role to get answers and find solutions. The following is a synopsis of our activities to date:

Statewide Surface Water Occurrence Survey. As mentioned above, in May 1997 ACWA began coordinating a voluntary statewide effort to sample reservoirs for the presence of MTBE. As part of the survey, water utilities were asked to use a sampling protocol to test reservoirs for MTBE levels at various points during the summer recreation season. A report on the survey is expected to be completed in early 1998.

Research into treatment technologies. ACWA is working with its member agencies to secure funding for research into treatment technologies to remove MTBE from drinking water. Several short- and long-term research needs have been identified, and water utilities are actively engaged in discussions with oil industry representatives to explore a number of options for funding and carrying out research projects.

Legislation. ACWA was active in passage of MTBE-related State legislation in 1997, and is developing language for proposed legislation in 1998. ACWA is considering proposals to address liability for environmental cleanups and drinking water treatment, notification of public water systems when pipeline or underground storage tank leaks occur, and access to private well information needed to develop basin-wide groundwater protection strategies.

Costs

Most drinking water systems in California are not equipped to remove MTBE. The limited research that has been done to date indicates that MTBE is more difficult and more expensive to remove from drinking water than other components of gasoline. Developing, constructing and operating treatment processes to remove MTBE will be tremendously costly at a time when public water agencies already face mounting costs to keep healthful water flowing to their customers taps.

Water treatment experts believe that air stripping and advanced oxidation processes currently offer the best options for removing MTBE from drinking water. For groundwater, the estimated cost of installing either of these processes is $1 million—$1.5 million per well. The price tag escalates dramatically if additional land must be purchased or other site-specific needs must be addressed. Operating and maintaining such a treatment system would cost up to $100,000 a year per well.

Since potentially hundreds of wells could be affected by MTBE, the total treatment costs could easily reach hundreds of millions of dollars in capital outlay alone. If alternative water supplies must be purchased, the cost can reach $400 per acre-foot, the amount of water used each year by two average families.

It should be noted that loss of groundwater supplies as a result of MTBE contamination could create additional demands on the San Francisco Bay-Delta estuary if agencies are forced to purchase alternative surface water supplies. Increased pressure on the already stressed Bay-Delta could negatively affect the ongoing water supply and ecosystem rehabilitation effort there.

Several water utilities already are incurring costs as a result of MTBE contamination. Santa Monica has spent about $5 million this year on sampling, investigation and replacement water supplies. Santa Clara Valley Water District has spent an estimated $500,000 this year in staff time and resources to monitor and test groundwater and surface water supplies, analyze the risk to its system and develop plans

to respond. South Tahoe Public Utility District has spent $200,000 since April 1997 to investigate MTBE contamination in its groundwater basin.

Beyond these costs and the expense of treatment, widespread MTBE contamination will result in some intangible costs such as loss of consumer confidence, which no water agency can afford, and societal costs such as reductions in property values.

Recommended Actions

ACWA members believe several actions are needed to protect water sources and drinking water consumers from the impacts of MTBE use.

1. Research funding. Significant dollars must be allocated for research into MTBE treatment technologies, occurrence, source protection and health effects. Millions of dollars are needed now and in subsequent years to accomplish both short- and long-term research efforts to bring treatment techniques on line and improve our understanding of how MTBE moves in the environment so we can better protect water sources. Research must also be planned, funded and carried out to fill the tremendous gaps in our knowledge of the health effects of MTBE in drinking water. The Federal Government bears a major responsibility for seeing that the research is funded and carried out.

2. Source protection. Action is needed at both the Federal and State levels to minimize the risk of MTBE contamination of our water sources. The State must get better data about leaking underground storage tanks, examine regulations governing their use, improve leak detection and reporting methods, and accelerate cleanups. Initiatives are underway to address storage tank issues, but the State must ensure that adequate resources are provided to get the work done. The State must also equip regional water quality control boards with funding and resources needed to deal with MTBE contamination and cleanup.

At the Federal level, leadership is needed in Congress to ensure that the source water assessment and wellhead protection programs authorized under the 1996 Safe Drinking Water Act Amendments are fully funded. The amendments allow States to use 15 percent of their State revolving fund (SRF) for projects that protect drinking water sources. In addition, 10 percent of the State's SRF funding for the first year can be spent on source assessment activities, including wellhead protection. Senator Boxer, California water agencies need a strong commitment from you to ensure that these programs receive the full appropriation.

Also at the Federal level, California needs flexibility to meet clean air goals without the use of additives such as MTBE that pose a threat to drinking water. HR 630, the Bilbray bill, is the type of legislation that takes that approach. It should be considered along with other measures.

Federal legislation is also needed to promote better regulation of interstate pipelines to prevent MTBE contamination of drinking water sources.

State, Federal and local agencies should examine recreational practices on reservoirs and ensure that there are adequate controls on motorized watercraft and fueling operations that may contribute to surface water contamination by MTBE.

And to address the "human factor" involved in refueling practices, industry and regulatory agencies must work to develop best management practices and ensure that they are followed at every stage in the handling, transport and storage of gasoline.

3. Ensure that water supply impacts are considered before chemicals are approved for use. There are growing indications that oxygenates such as MTBE may not be needed in the long term to achieve the air quality goals sought by both State and Federal agencies. Recent actions by Chevron Corp. and Tosco Corp. recommending a phase-out of MTBE reinforce the need to fully consider impacts on water supply and the potential for other cross-media pollution before gasoline additives and other chemicals are approved for use.

Conclusion

California simply cannot afford to lose any of its limited water resources to MTBE contamination. According to projections by the State's Department of Water Resources, California will be 4 million to 6 million acre-feet short of water each year by 2020 without additional facilities and water management strategies. Given these growing demands, protection of our State's drinking water sources must be given full consideration in every forum in which MTBE and other oxygenates are evaluated.

Even if MTBE were taken out of gasoline tomorrow, we will still have to deal with significant amounts of this contaminant in our environment. The potential for drinking water contamination and the tremendous treatment costs involved warrant serious consideration by this committee as it explores any further measures affecting MTBE use.

We are certain, Senator Boxer, that with your deep and caring concern for the health of children and families, you will work diligently with us to protect California's water supplies and the health of Californians. ACWA and its members stand ready to assist this committee and other agencies and industry representatives as they seek to address MTBE and related issues.

STATEMENT OF NACHMAN BRAUTBAR, M.D., UNIVERSITY OF SOUTHERN CALIFORNIA SCHOOL OF MEDICINE

Honorable Senator Boxer, members, ladies and gentlemen, it is an honor to testify in front of the United States Senate Environment and Public Works Committee. My name is Dr. Brautbar, a medical doctor from Los Angeles, and a 23-year resident and citizen of California. I am testifying today as a physician and scientist. I have no political agenda and have not received any compensation, from either the opponent or proponent, to be here today.

I practice medicine, treat and diagnose patients, and teach at the University of Southern California School of Medicine and hold the title of Professor of Clinical Medicine, and former Associate Professor of Pharmacology. I am a member of the National Society of Toxicology, American College of Toxicology, and have published over 160 scientific medical papers in medicine, toxicology and pharmacology. My resume is attached to your package as Exhibit "A" [*Note:* retained in committee files].

In the last 5 years I have studied the health effect of MTBE in gasoline on patients, and personally examined over 350 patients with MTBE health related problems from drinking water contaminated with MTBE and gasoline. The patients I have seen and examined have been exposed to MTBE and gasoline in the drinking water, due to contamination from leaking gasoline tanks. Those 350 patients who did not know that they were exposed to MTBE in gasoline developed skin rashes, sinus congestion, severe headaches, loss of memory, shortness of breath, asthma, diarrhea and abnormal white blood cell life span. These symptoms which started in 1992 were verified by review of medical records, examination and laboratory testing. Before these patients were exposed to MTBE and gasoline in drinking water none of them experienced any of these symptoms and findings. Removing these patients from MTBE and gasoline contaminated water resulted in some improvement and in some, complete reversal of these pathological and disabling findings.

In addition to the objective studies and physical examination documenting the validity of those complaints, I have conducted studies of the blood cells in these patients. These tests showed that the life span of the white blood cells of MTBE in gasoline exposed patients was reduced significantly, indicating serious harmful effects of MTBE in gasoline in linewith the position of leading physicians and scientists worldwide, that MTBE in gasoline is harmful to humans (Exhibit "B"). My studies have been published in scientific peer-reviewed journals, preprints of these manuscripts are attached here as Exhibits "C" and "D". [*Note:* exhibits are retained in committee files].

MTBE causes cancers in many organs and tissues in significant numbers of experimental animals and these cancers are identical to those exposures by the same doses as has been described for other carcinogens such vinyl chloride and benzene which are known human carcinogens. My opinion is supported by the general agreement among experts in chemical carcinogens, that a substance which causes cancer in significant numbers of experimental animals in well documented assays, poses a presumptive carcinogenic risk to some humans even in the absence of confirmatory experimental data in humans. Even though there is no recognized method as yet for establishing the existence of a threshold for a carcinogen in human populations, these principles, which are accepted by scientific and medical experts throughout the world, have served for many years and are still serving as the basis for some public health and policy and regulatory action on carcinogens. Specifically, the International Agency for Research on Cancer (IARC) of the world health organization in its supplement 7 of the monograph, 1987, page 22, indicates that the information compiled from the first 41 volumes of IARC, shows that of the 44 agents for which there is sufficient or limited evidence of carcinogenicity to humans, all 37 have been tested adequately in experimentally produced cancer in at least one animal species . . . -in the absence of adequate data on humans it is biologically plausible and prudent to regard agents for which there is sufficient evidence of carcinogenicity in experimental animals as if they presented a carcinogenic risk to humans. (Exhibit "E" attached) [*Note:* retained in committee files].

The permissible water levels for benzene and vinyl chloride, which are carcinogenic, has been reduced extensively to levels of 0.7 for benzene and 0.5 for vinyl chloride micrograms per liter in California, and 1 micrograms per liter for benzene

and 2 micrograms per liter for vinyl chloride in North Carolina. In February 1996 the U.S. EPA conducted an inter agency assessment of potential health risks associated with oxygenated gasoline, which was concerned mainly with MTBE. Using the EPA's own data from that meeting, table 5, my colleague Dr. Mehlman has calculated the exposure level for MTBE. Based on the lymphoma and leukemia data from the EPA's table 5, the upper bound limit cancer risk is 4 x 103 milligrams per kilograms per day which means in simple language that this level of exposure to MTBE 4 individuals per 1,000 may develop cancer. This is an extremely high risk and such an exposure is not justified. Specifically, the State of North Carolina classifies water suitable for drinking to mean "the quality of water which does not contain substances in concentrations which either singularly or in combination is ingested into human body, may cause death, disease, behavioral abnormalities, congenital defects, genetic mutations will result in incremental lifetime cancer risk in excess of 1 per 1 million." Thus, based on North Carolina's definition and the maximum risk of cancer of 1 per 1 million, the reported oral potency in risk for leukemia and lymphoma of 4 per 1 million violates these provisions.

The substantial weight of evidence clearly indicates that MTBE is carcinogenic. This is reported by several studies where MTBE was shown to cause cancer in 2 different species of experimental animals. The medical scientists are further clear that pregnant women, young children, people on medications, and sensitive individuals are at even greater risk for developing cancers. Thus the levels of exposure for these individuals may be extremely high.

The permissible exposure levels of contaminants in drinking water for possible or probable human carcinogens are set extremely low, sometimes even as low as for a known human carcinogen. Accordingly, I am of the opinion that in order to reduce or prevent unnecessary risk of individuals developing cancers the drinking water standard should be no greater than that for benzene.

For a susceptible individual, there may be 100 times greater risk for contracting and dying from cancer. The hundred times greater susceptibility factor is based on an analogy to MTBE in gasoline. Cross sensitivity of MTBE in gasoline is 100 times greater than MTBE alone and causes a tremendous variety of acute illnesses including neurological, allergic and respiratory in humans. This indicates strong synergistic interaction with other chemicals as in the case of, for instance, asbestos and smoking causing lung cancer. The smoking factor increases the risk of asbestos related cancer by a factor of multiplied 60 to 80.

This issue of synergistic effects, meaning exposure to MTBE alone may not be as carcinogenic and as toxic as exposure to MTBE and gasoline due to multiplying the risk factor by a factor of 100. The synergistic effect may occur out of joint or separate exposure to single compounds, as well as one of exposure to mixture of potentially carcinogenic compounds, that is exactly what is happening with MTBE and gasoline that penetrates the drinking water from corroded tanks such as in the case of Wilmington, North Carolina, such as in the case of Santa Monica, California, and such as in the case of Glenwood, California. It is the issue of the synergistic effect of MTBE and gasoline contaminating the drinking water and consumed by unknowing citizens, children, pregnant women, elderly and patients with chronic diseases on a daily basis. This synergistic effect is described nicely and summarized on Exhibit "F". [*Note:* retained in committee files].

My office receives many phone calls daily from patients who are sick and have been exposed to MTBE and are seeking medical help. This problem is not unique to the citizens of California. Patients in Alaska, Maine, New Jersey, North Carolina, Pennsylvania, Michigan and others have been presenting with these same problems as a result of exposure to MTBE in gasoline. Indeed, the State of Alaska has banned the used of MTBE in gasoline as a result (Exhibit "G"). [*Note:* retained in committee files].

History is a good predictor and teacher of the future. Throughout my 30 years as a physician, I have seen patients who suffered lung disease and lung cancer from cigarette smoking, but was told by the cigarette companies that cigarette smoking is safe, the rest today is indeed history.

Indeed our great State of California under the leadership of the Honorable Senator Mountjoy is, in my opinion, following in the footsteps of Alaska. Most recently Chevron, the States largest refiner, announced that the company is asking the State air resource board to allow it to make gasoline without MTBE, saying in a statement that MTBE and similar chemicals do little to reduce smog and is a threat to water supplies. Seven wells in Santa Monica have been shut because of MTBE contamination and water experts fear that MTBE will cloud all wells in years to come. Chevron's K.C. Bishop was quoted to say that when customers are concerned Chevron is concerned. I believe that the writing is on the wall, scientific data and medical studies are clear, concise, and the public, as well as manufacturers such as

Chevron are realizing that exposing the public to MTBE in gasoline is a dangerous and is uncalled for.

STATEMENT OF NANCY J. BALTER, PRINCIPAL, INTERNATIONAL CENTER FOR TOXICOLOGY AND MEDICINE

I appreciate the opportunity to submit testimony to the Environment and Public Works Committee of the United States Senate. My curriculum vitae is attached. Briefly, I am a pharmacologist/toxicologist who has spent most of my career on the full time faculty at Georgetown University School of Medicine where I did research and taught courses in pharmacology and toxicology to medical students and undergraduates. In 1995, I retired from academics to move to Colorado. I am currently a Principal with the International Center for Toxicology and Medicine, where I work as a consultant on a variety of environmental and occupational health issues. As a consultant to the Oxygenated Fuels Association since 1993, I am very familiar with the health-related studies of oxygenated gasoline in general and MTBE specifically. I have served as a consultant and peer reviewer for the U.S. EPA, CDC and the National Academy of Science on this issue, and have written a paper on the acute health effects associated with exposure to oxygenated gasoline, which will be published in the December issue of the journal, Risk Analysis. A copy of this paper is also attached to this statement.

My testimony deals with the health implications of the continued use of MTBE in reformulated and oxygenated gasoline. In addressing this issue, the potential for toxicity of MTBE cannot be considered in isolation, but must be weighed against the benefits associated with its use in gasoline. Gasoline, itself, is known to contribute significantly to human exposures to numerous toxins, including carbon monoxide, ozone, and known human carcinogens such as benzene and 1,3-butadiene. The rationale behind the reformulation and addition of oxygenates to gasoline is to reduce these exposures. Thus, the focus in the consideration of health effects should be how the risks from MTBE exposure from oxygenated gasoline compare to the benefits associated with the decreased exposure to toxic gasoline-related emissions that occurs as a result of addition of MTBE to the gasoline.

The major route of human exposure to MTBE is through inhalation of air containing MTBE that has evaporated from gasoline or been released in the exhaust from vehicles. In addition, there can be human exposure associated with MTBE in water. The most significant source of MTBE in water is gasoline leaks and spills, including leakage of underground storage tanks. Gasoline contamination of water is a problem whether or not the gasoline contains MTBE. The question is, how does the movement of MTBE from gasoline to water affect the benefit risk equation for oxygenated gasoline vs. conventional gasoline?

We know a great deal about the toxicity of MTBE and the exposure concentrations necessary to cause toxicity. There has been extensive animal testing for acute and chronic toxicity, including carcinogenicity, as well as both experimental and epidemiological studies in humans. The animal studies involve exposures that are many orders of magnitude above the concentrations to which humans would be exposed. The results of these studies and their extrapolation in the prediction of human risk are considered separately for carcinogenic and non-carcinogenic endpoints since the approaches for extrapolating from animals to humans are different.

With respect to non-cancer endpoints, the thresholds for toxicity in animals are sufficiently high that toxicity in humans exposed to MTBE in air as a result of its use in oxygenated gasoline are not expected to occur. The epidemiological studies comparing health effects in areas using conventional vs. oxygenated gasoline, and experimental studies involving controlled exposure to MTBE at environmentally relevant concentrations support this conclusion. These data and conclusions are discussed much more fully in the attached paper.

Although the concentration of MTBE in water contaminated as a result of a gasoline leak or spill can be high, humans are not likely to be exposed at these levels because the presence of MTBE in water at very low concentrations impacts the taste and smell characteristics of the water such that exposure will be self-limiting. In situations where the MTBE concentration in water is high, there might be short-term exposures that result in irritant effects. However, longer exposures at these levels will not occur. Although there are no animal studies involving long-term drinking water exposure, the threshold for chronic, non-cancer toxicity can be extrapolated from a subchronic study involving oral gavage exposure (i.e., the chemical was delivered directly into the stomach by tube) or from the lifetime inhalation exposure studies. Using either approach for extrapolation, it is clear that the water safety level that would protect against chronic, non-cancer toxicity is well above the

threshold for odor and taste changes. In other words, from a practical point of view, humans will not be chronically exposed to MTBE in water at concentrations associated with toxicity.

MTBE causes several types of tumors in animals exposed to high concentrations of the chemical. While it is generally assumed that a chemical that causes cancer in experimental animals poses some cancer risk to humans, the scientific and regulatory communities are recognizing that there are exceptions to this conservative assumption depending on the mechanism of action of the chemical. For example, when the mechanism of cancer induction is one that only occurs at high exposures where cell death and tissue damage occur, such an effect would not be expected to occur in humans since the exposure would be to far lower doses than in the experimental animals. Other mechanisms of cancer induction related to the effects of chemicals on hormonal balance or an animal-specific cellular component are similarly not necessarily relevant for predicting human risk. On the other hand, a chemical whose mechanism of action involves damage to DNA is likely to have a similar effect in humans. MTBE does not damage DNA, and there is some evidence that its carcinogenic effect in animals may involve mechanisms not relevant to predicting human risk; additional study is taking place to clarify this issue. For the purposes of this discussion, however, it will be assumed that the animal cancer response is a relevant predictor of human risk.

The cancer risk calculations contained in the September 2, 1996, California Environmental Protection Agency briefing paper on MTBE are as follows: the calculated increase in risk associated with breathing MTBE as a result of its use in gasoline is one to two lifetime cancer cases per million people exposed; balanced against this is a calculated decreased risk of about 60 per million that occurs because the use of reformulated gasoline reduces the opportunity for gasoline-associated exposure to known human carcinogens such as benzene and 1,3-butadiene. Adding the potential risk associated with exposure to MTBE through water at the upper limit of the threshold for taste and odor recognition, the net benefit of MTBE on human cancer risk remains above 50 per million.

In summary, there is accumulating evidence that the projected health benefits of oxygenated and reformulated gasoline are, in fact, being realized. It is against this benefit that the risks of gasoline-related MTBE exposures need to be weighed. We know that there will be human exposure to MTBE as a result of its use in gasoline these exposures are primarily a result of breathing air containing evaporative and exhaust products of gasoline, but may also occur from gasoline-contaminated water supplies. However, the exposures from these sources are below the threshold for human toxicity. Whether or not MTBE exposure increases human cancer risk remains an area of scientific debate. But even if we make the assumption that MTBE is a potential human carcinogen, the predicted cancer risk associated with MTBE-containing reformulated gasoline is less than that associated with conventional gasoline. This is because compared to conventional gasoline, the use of reformulated gasoline results in decreased exposures to known human carcinogens such as benzene.

A recently published study has reported effects on the life cycle of white blood cells in a group of individuals exposed to water contaminated as a result of an underground storage tank leak. The water reportedly contained low levels of MTBE and benzene. There are some significant questions about the methods that were employed in the interpretation of this study, and the findings are seemingly implausible given the fact that the studies were done almost a year after the cessation of the exposure. In any case, however, the reported exposure was to both benzene and MTBE, making it impossible to conclude that MTBE was the causative agent. Given the fact that benzene is a known human carcinogen and its primary target in humans is the blood system, benzene is a much more likely candidate for causing the reported effects than is MTBE.

The scientific and regulatory communities will continue to study MTBE, and some questions do remain. These have been identified in several reviews that have been completed in the last year. While the toxicity of MTBE itself has been well studied, studies that directly compare the effects of gasoline, with and without MTBE, are planned but not yet completed. A question has also been raised as to whether there are some individuals who are uniquely sensitive to MTBE. Whenever a new chemical or drug is introduced, this possibility always exists. While nothing in MTBE's toxicological profile predicts that there will be such a sensitivity, at least one study is underway to investigate this possibility.

Another question that has been raised is whether it is necessary to do toxicological studies in animals exposed to MTBE in drinking water. With the use of a technique known as physiologically-based pharmacokinetic (PBPK) modeling, it is possible to identify the drinking water dose equivalents of the exposure regimens

used in the inhalation studies. This extrapolation is based on the principle that it is the dose of a chemical delivered to the target tissue that determines the effect, independent of whether the dose was delivered by inhalation or by drinking water. The PBPK model is a computer simulation of the body, including the various organs (target tissues), each with its characteristic blood flow and pathways for handling the chemical; routes of elimination of the chemical are also included. Both inhalation and drinking water dosing can be simulated, and the target tissue concentrations of MTBE and its metabolites determined as a function of time. By doing this, the inhalation dose response data can be translated to target-tissue dose response data. The simulated drinking water exposure that results in similar target tissue doses can then be determined as a basis for the extrapolation. A PBPK model for MTBE and its major metabolite, TBA, has been published and is currently being validated for route-to-route extrapolation.

Use of PBPK modeling as the basis for route-to-route extrapolation has been used for a number of other chemicals and can be done with a high degree of confidence. In the case of MTBE, it may well be the only way to determine dose-response data for drinking water exposures since the odor and taste properties of MTBE are likely to prevent animal exposures at levels high enough to provide an adequate test of toxicological response. Some studies have been reported involving oral exposure using a gavage method, where a bolus of MTBE is introduced directly into the stomach. However, such studies are a poor simulation of a drinking water exposure because the dose is introduced all at one time rather than in increments over the course of the day. In this respect, inhalation exposure provides a better simulation of the exposure that occurs.

Continued examination and confirmation of the benefits and risks associated with the use of MTBE in reformulated gasoline is appropriate. However, there are adequate data at this point to support the safety and benefits of continued use of MTBE-containing reformulated gasoline as these studies are being done.

Causality Assessment of the Acute Health Complaints Reported in Association with Oxygenated Fuels

(By Nancy J. Balter, Ph.D., International Center for Toxicology and Medicine, Georgetown University, Washington, DC)

Abstract

In some areas where oxygenated fuel programs have been implemented, there have been widespread complaints of non-specific health effects attributed to the gasoline. There are a number of hypotheses that can account for this apparent association. This paper examines the hypothesis that the use of oxy-fuel (either oxygenated gasoline or reformulated gasoline) results in exposure of the general population to one or more chemicals at concentrations that cause toxicologic injury. Although several oxygenates can be used in oxy-fuels, this analysis focuses on MTBE because it is the most widely used oxygenate and because the data base of relevant toxicologic data is greatest for this oxygenate.

The causal assessment is based on an evaluation of the qualitative and quantitative plausibility that oxygenated fuel-related exposures have toxicological effects, and the epidemiologic studies that directly test the hypothesis that the use of oxygenated fuels causes adverse health effects. The plausibility that chemical exposures related to oxy-fuel use cause toxicological effects is very low. This determination is based on consideration of the exposure-response and time-action profiles for relevant toxicological effects of MTBE in animals, experimental MTBE exposure studies in humans, and the possibility that the addition of MTBE to gasoline results in toxicologically significant qualitative and/or quantitative changes in gasoline-related exposures. Similarly, the epidemiologic studies of oxy-fuel exposed cohorts do not support a causal relationship between oxy-fuel use and adverse health effects. Although the data are insufficient to rule the possibility of unique sensitivity in a small segment of the population, the strength of the evidence and the availability of other more plausible explanations for the health complaints reported in association with oxy-fuels support a high degree of confidence in the conclusion that MTBE-containing oxygenated fuels are not the cause of acute toxicity in the general population.

Introduction

The use of chemicals ("oxygenates") to increase the oxygen content of gasoline has increased dramatically since 1988, as a result of voluntary and government-mandated programs to reduce emissions of gasoline-associated air pollutants. The Clean

Air Act Amendments of 1990 mandated the use of specific types of oxygenate-containing gasolines in non-attainment areas for carbon monoxide and ozone. In carbon monoxide non-attainment areas, the oxygenate was required to be added to conventional gasoline during the winter months such that the final gasoline product ("oxygenated gasoline") contained 2.7 percent oxygen by weight. In ozone non-attainment areas, year-round use of a reformulated gasoline product containing a minimum of 2.0 percent oxygen by weight was required. Other than the oxygenate, this gasoline ("preformulated gasoline" or "RFG") generally contains the same components as conventional gasoline, although in different proportions in order to meet the emission requirements of the Clean Air Act Amendments.

In a minority of areas where oxygenated gasoline or RFG (collectively referred to as "oxy-fuel") has been introduced there have been reports of widespread acute health complaints characterized by non-specific symptoms such as headache, cough, eye irritation, nausea, burning of the nose and throat, dizziness and disorientation. Several hypotheses can be put forward to explain this apparent association: (1) that the addition of the oxygenate to gasoline results in exposure to one or a combination of chemicals at concentrations above the threshold for causing toxicity; (2) that extensive media reports concerning the public resistance to government-mandated oxy-fuel and claims of adverse health effects caused members of the general public to attribute non-specific symptoms from a variety of causes to the use of oxy-fuels; (3) that the odor of the oxy-fuel, which is distinctive and can be perceived at lower concentrations compared to conventional gasoline,[1] triggers a psychogenic response resulting in acute symptoms; (4) that odor and media coverage are both component causal factors in the triggering of symptoms and their attribution to oxy-fuels. The role of odors and psychological factors in the response to oxy-fuels is discussed in an accompanying paper.[2]

This paper focusses on the first hypothesis, that oxy-fuel emissions result in exposure of the general population to one or more chemicals at concentrations that cause toxicologic injury. Although the oxygenates themselves are the most obvious candidates for examination, it is also possible that the addition of the oxygenate to gasoline results in qualitative and/or quantitative changes in exposure to other components of gasoline that contribute to a toxicologic response. Such exposures could result from evaporative emissions from gasoline, exhaust emissions of combusted or uncombusted gasoline, or atmospheric transformation products of chemicals from any of these sources. The causal evaluation considers, first, plausibility, and then the findings of epidemiologic studies of oxy-fuel exposed cohorts. Evidence relating to plausibility includes data from experimental studies involving animal or human exposure to chemicals in oxy-fuel emissions. Plausibility depends not only on whether qualitatively similar effects to those reported in exposed populations are seen in experimental studies, but also on a quantitative evaluation of whether humans could plausibly be exposed to concentrations of the chemical(s) sufficient to cause a given toxicologic effect. Since this evaluation was stimulated by the reports of widespread health complaints, the quantitative aspect of the evaluation focuses on whether exposure is above the threshold for an effect in the average member of the general public. In situations where there is an absence of relevant data to assess plausibility, the evaluation is based on theoretical considerations.

Plausibility

The evaluation of plausibility focuses on MTBE (methyl-tertiary-butyl ether), the most commonly used oxygenate in oxy-fuels and the most commonly implicated causative agent in anecdotal reports of adverse effects.[3] Since the evaluation of plausibility involves qualitative and quantitative considerations, the exposure-response characteristics of experimental exposure to MTBE are compared to MTBE exposures in real-life situations. Activity and microenvironmental MTBE exposures in the general population have been estimated by USEPA.[4] Most relevant to the evaluation of acute health effects in the general population are the activity-related exposures associated with automobile refueling and commuting. Self-service automobile refueling is associated with the highest acute MTBE exposure concentrations; a reasonable worst-case estimate of exposure is 2–10 ppm for several minutes. Exposure to MTBE in gasoline stations, not associated with self-service refueling, or during commuting involves exposures that are an order of magnitude or more lower in concentration, but somewhat longer in duration. The presence of MTBE in ambient air, public buildings and residences can result in longer duration exposures, but at concentrations that are quite low, in the range of 0.001–0.01 ppm.

Exposure of animals. Most relevant to a consideration of plausibility are animal experiments in which the exposure is to a mixture of gasoline and MTBE, where the findings are compared to animals exposed to the same gasoline to which MTBE had not been added. Although such studies are planned, none have been reported

to date. A number of studies involving animals exposed to atmospheres containing MTBE daily for up to 24 months have been reported; the findings of these studies are considered here only as they relate to the target organ systems defined by the anecdotal reports of acute health effects. Most of the studies involved at least subchronic exposure for 6 fur/d for a minimum of 4 weeks. For each study, the record of daily clinical observation of study animals was reviewed to identify signs of acute health effects. These clinical observations were generally made after, not during, the daily exposure period.

Signs of central nervous system depression, including ataxia, hypoactivity, lack of a startle reflex, and twitching of the eyelids, were generally seen in rats and mice exposed to 3,000 or 8,000 ppm MTBE. These effects were transient and reversible; no cumulative effects were observed [5] The time to onset of the CNS effects of MTBE was dependent on the exposure concentrations.[6 7]

No clinical signs of gastrointestinal effects were observed in the animal studies, nor was there histopathological evidence of effects on this organ system following inhalation exposure. Chronic inflammation of the nasal turbinates and pharynx was reported in rats exposed to 1000 or 3000 ppm MTBE, 6 hr/d, for 9 days.[8] However, similar findings were not reported in other studies, including chronic bioassays in rats and mice involving exposures up to 8,000 ppm MTBE.[9 10] MTBE exposure causes concentration-dependent eye irritation, especially in rats. In a 6 hr. single exposure study,[11] rats in the high exposure groups, 4,000 and 8,000 ppm, had lacrimation 1 hour, but not 6 or 24 hr after termination of the exposure. Ocular effects, including swollen and/or encrusted periocular tissue and lacrimation, were reported in all rat studies and in some mouse studies. Signs of ocular irritation in rats were routinely recorded at and above 3,000 ppm, but not at 400 or 800 ppm. The time course of the appearance of ocular irritation was concentration-dependent, appearing after 2–3 weeks of daily exposure in rats exposed to 8,000 ppm MTBE, and not until at least 9 weeks (and often much longer) in animals exposed to 3,000 ppm.[9] Ophthalmologic examination of rats exposed to 8,000 ppm daily for 13 weeks found no treatment-related abnormalities.[5]

Based on these studies, the LOAEL for MTBE in rodents is 3,000 ppm and the threshold for adverse effects is between 800 and 3,000 ppm, both for repeated exposures of 6 hr/d. This is more than three orders of magnitude above the chronic exposures expected in the general population associated with commuting or the presence of MTBE in ambient air. Acute exposures associated with refueling, are not expected to exceed 10 ppm for a period of 10 min. representing a cumulative exposure of 100 ppm min. This compares to 144,000 ppm min at the most conservative NOAEL (400 ppm with exposure for 360 min) for irritation reported in the animal studies. Applying a safety factor of 1,000, short-term peak exposures to MTBE associated with refueling would be well below this extrapolated threshold for irritative effects in humans. Although for some eye irritants sensitization can occur with chronic exposure, the large margin of safety accommodates this possibility.

Another approach to determining the threshold for irritative effects is based on a mouse bioassay in which sensory irritation is expressed as the exposure concentration (ROD) that produces a 50 percent decrease in respiratory rate.[12] Based on the empirical observation of a good correlation between the RD60 and the occupational TLVs for a number of structurally diverse chemicals, it has been suggested that occupational exposure limits of 3 percent of the RD50 will be generally non-irritating and, therefore, appropriate as a TLV.[13 14] The ROD for sensory irritation for MTBE is 4600 ppm,[15] which would extrapolate to a suggested TLV of 140 ppm.

Experimental human exposure to MTBE. Experimental studies of the effects of MTBE exposure on healthy humans have involved 1 hour double blind exposures to 1.4 ppm [16] or 1.7 ppm,[17] MTBE; a third study [18] involved 2 hour exposures to 2, 25 and 50 ppm MTBE, but did not include a clean air comparison exposure. The studies used both subjective and objective measures to assess the effects of MTBE on CNS function and eye and nasal irritation. The studies were consistent in demonstrating that exposure to MTBE under controlled conditions, at concentrations relevant to human exposures, had no significant effects on the central nervous system or eye and nasal irritation. Although limited in that the studies examined only healthy subjects, they do not support the plausibility that exposure to MTBE, at levels associated with its use in gasoline, will cause CNS toxicity or have irritative effects. The studies were not of sufficient size to necessarily identify individuals who were uniquely sensitive.

Exposure to other chemicals or chemical combinations associated with the use of MTBE in gasoline. The acute health complaints that have been reported in some of the areas where oxy-fuels have been introduced are non-specific and typical of irritative responses that occur to many diverse chemicals at high enough levels of exposure. Both evaporative and exhaust emissions from conventional gasoline, and

their degradation products, include chemicals or mixtures of chemicals that can cause headache, dizziness, irritation of the eyes and respiratory tract, gastrointestinal symptoms, etc. The effect of MTBE addition on other exposures associated with gasoline would ideally be tested in studies comparing the effects of gasoline with and without MTBE. However, no such studies have been reported. Since it is at least theoretically possible that the addition of MTBE to gasoline results in qualitative and/or quantitative changes in other gasoline-related exposures, with those changes causing toxicologic effects, some candidate chemicals were identified for consideration. Exposure to formaldehyde (FA), a combustion product of MTBE, and tertiary butyl formats (TBF), the major photochemical degradation product of MTBE, could increase as a result of the use of MTBE in oxyfuels, and are evaluated here as possible causes of health effects. The possibility of additive or synergistic interactions unique to oxy-fuel emissions is also considered.

The acute health effects of FA are, to some extent, similar to the symptoms reported in association with oxy-fuels. FA is an ocular and upper respiratory tract irritant; other oxy-fuel symptoms such as headache and gastrointestinal complaints are less commonly associated with FA.[19] Ambient and microenvironmental concentrations of FA, and the effect of MTBE on the contribution of gasoline emissions to these levels have been reviewed by USEPA,[20] which concluded that ambient FA concentrations in urban areas average 1–3 ppb, with peaks as high as 5–8 ppb at some urban locations. Microenvironmental concentrations in semi-enclosed areas with automobile exhaust can be considerably higher; the maximum concentrations of FA reported in parking garages and in the passenger compartments of automobiles are 34 and 29 ppb, respectively. Based on modeling, USEPA estimated that addition of 15 percent MTBE to gasoline would result in a 1–2 percent increase in primary FA emissions, although this increase would be at least partially offset by a decrease in the secondary formation of FA from gasoline-derived VOCs, which are reduced by addition of MTBE to gasoline.

The threshold for acute irritation by FA is generally considered to be between 100 and 3,000 ppb,[20] although some individuals report discomfort at lower concentrations. Asthmatics do not appear to be at particular risk from low concentrations of FA.[21] The threshold for irritation is well above ambient FA concentrations and maximum reported microenvironmental levels, even considering the additional contribution of MTBE. While it is theoretically possible that an individual who is unusually sensitive to FA will be affected by even very small increases in microenvironmental exposure, such an individual would be expected to be affected by gasoline, independent of the presence of MTBE.

The major atmospheric degradation product of MTBE is tertiary-butyl formats (TBF)[22], a chemical uniquely associated with the use of MTBE-containing oxy-fuels. No data on the toxicology of TBF could be identified. Von Oettingen [23] reported limited range finding acute toxicity data for other alkyl formats esters, including n-butyl formate, which suggest that they are sensory and respiratory tract irritants. However, the data presented are insufficient for establishing NOAELs or LOAELs for any of the formates, or for predicting the effects of TBF. In the absence of primary toxicity data for TBF, the threshold for irritation has been estimated based on the empirical relationship between irritant (nasal pungency) and odor thresholds, with the odor threshold for TBF being estimated based on extrapolation from data for a structurally related series of chemicals, the alkyl acetate esters [24].

Apredictable relationship between odor and sensory irritation thresholds has been established for many chemicals, including alkyl acetate esters,[26] such that if the odor threshold is known, the irritation threshold can be predicted. The odor threshold for TBF has not been experimentally determined, but has been estimated to be 2.6 ppm [24] based on the relationship between the standardized odor thresholds of a series of alkyl formates and acetates,[26] and the relationship between the odor thresholds of a series of alkyl acetates, including tertiary-butyl acetates. Based on the empirical relationship between odor threshold and nasal pungency threshold, the sensory irritation threshold is estimated to be 505 times the odor threshold, or 1,313 ppm. This threshold is reasonable when considered in the context of the data for other similar chemicals.[24]

A worst-case estimate of the concentration of TBF in ambient air associated with the use of MTBE containing oxy-fuel is 0.2–0.3 ppb.[28] Although there is uncertainty in both the estimated human exposure to TBF and its sensory irritation threshold, since both are based on model predictions rather than actual data, the predicted sensory irritation threshold is six orders of magnitude above a worst case estimate of TBF exposure, providing a very large margin of safety.

The likelihood that MTBE or its combustion or degradation products is the cause of acute toxicity in humans is low given the large margin between the observed, extrapolated or predicted thresholds for adverse effects in humans, and exposures that

can occur as a result of the use of MTBE in oxy-fuels. However, since exposure to MTBE and its breakdown products always occurs as part of a complex mixture of VOCs associated with exhaust and evaporative gasoline emissions, subthreshold exposure(s) to MTBE and/or its breakdown products could interact, additively or synergistically, with other chemicals in ambient air or microenvironments where gasoline exposures occur, to cause adverse effects not seen in the absence of MTBE.

Synergistic interactions have been reported for sensory [23] and lung [30] irritation in some animal studies. Where such interactions were seen, exposure concentrations were well above the thresholds for the individual chemicals. An additive or, in the case of sensory irritation, a less than additive response, was reported when exposure concentrations were low. Since exposure to MTBE or its breakdown products are well below the threshold for toxicity, even considering the uncertainties inherent in some of the projections, there is no basis for expecting synergistic interactions.

Many of the effects that have been attributed to oxy-fuels, including eye irritation, nose and throat burning, and cough, relate to sensory irritation. These responses are mediated via common chemical sense receptors, which are activated by a nonspecific physical interaction between the chemical and the free nerve endings located in mucosal tissue, with the threshold for response primarily a function of the chemical's physical chemical properties.[31] Physical chemical properties are similarly thought to determine the chemical's threshold for odor, vagally mediated respiratory tract irritation, and CNS effects.[32] If the interaction between chemicals and the receptors that mediate the types of responses that have been associated with oxy-fuels is nonspecific in nature, additive effects of chemicals found in mixtures would be expected.

Additive interactions between MTBE and/or its breakdown products and other atmospheric or microenvironmental contaminants are plausible. Although the exposure to potentially irritating chemicals such as MTBE, FA and TBF will increase with addition of MTBE to gasoline, exposure to other potentially irritating chemicals, including VOCs and ozone, is expected to decrease. The exposure concentrations of individual chemical irritants resulting from MTBE addition appear to be sufficiently below their respective thresholds that additive effects resulting in toxicity would not be expected. However, the net effect of addition of MTBE to gasoline on irritant chemical exposures and the nature of the interaction between the chemicals require additional study.

In summary, the plausibility evaluation considered what is currently known or predicted about the toxicology of MTBE and its atmospheric and combustion degradation products, and the effects of MTBE on exposures to, and resulting toxicity of, evaporative and exhaust gasoline emissions. These data and predictions provide little support for the plausibility that MTBE-containing oxy-fuels cause an increase in acute toxicity in the general population compared to conventional gasoline.

Epidemiological studies of populations exposed to oxy-fuels

Several epidemiologic study designs have been used to examine the relationship between oxyfuels and adverse health effects. They are considered here only insofar as they provide information or insight relevant to the question of causation. Alaska. The introduction of oxygenated gasoline Alaska was associated with numerous complaints of health effects. In response, the Alaskan Department of Health, in cooperation with the Centers for Disease Control (CDC), executed several related studies [33 34 35 36 37 38] that assessed exposure using stationary, personal and biomarker monitoring, and health effects based on responses to a questionnaire, number of emergency room admissions or number of health insurance claims.

The CDC study in Fairbanks [33 34] assessed exposure and effects in December, when oxygenated gasoline was being used (Phase D, and in February (Phase II), 2 months after suspension of the oxygenated gasoline program in Alaska. The prevalence of self-reported symptoms, including headache, eye irritation, burning of the nose and throat, cough, nausea, dizziness and spaciness, was increased in Phase I compared to Phase II. Occupationally exposed workers whose post-shift blood MTBE concentrations fell in the upper quartile were more likely than those with lower MTBE blood concentrations to report having one or more key symptoms on the day the blood sample was taken, consistent with an exposure-response relationship.

Questionnaire-based interviews were conducted during Phase I in convenience samples of individuals who differed considerably in their potential exposure to gasoline (based on the reported number of hr/wk spent in an automobile). Although the number of subjects was small, no exposure response was demonstrated by the symptom prevalence in the three groups.[36] Emergency room visits with complaints of headache were not increased during the period of oxygenated gasoline use,[36] nor were the number of health insurance claims for headache, respiratory tract complaints and asthma.[38]

The increased prevalence of symptoms in Phase I compared to Phase 11 is consistent with an association with oxy-fuel use, although the high level of public attention that preceded the introduction of oxygenated gasoline in Alaska is a significant confounder. Several other factors must be considered in the interpretation of the Alaska findings. The key symptoms considered in the study are non-specific and have numerous potential causes, including exposure to gasoline emissions, independent of the presence of an oxygenate. The Alaska study provides no comparative data for the expected prevalence of these symptoms either in individuals exposed to gasoline not containing an oxygenate, or in the general population, not exposed to gasoline.

To resolve some of these questions, CDC conducted two similar investigations: in Stamford, Connecticut,[39] [40] mandated oxygenated gasoline was used, but there had been no adverse publicity; in Albany, New York,[41] an oxygenated gasoline program was not in effect. These comparison studies were not done concurrently, did not use identical methods for the identification of study subjects or assessment of health complaints, and were conducted at different times of the year such that the prevalence of seasonal illness could have been different. Although not ideal, these comparison studies do provide some insights into the factors responsible for the findings in the Alaska study.

The prevalence of key symptoms was similar in Stamford and Albany both for individuals who had potential occupational exposure to gasoline and commuters (Table 1). Although the prevalence of symptoms in occupationally exposed individuals in Fairbanks was higher than in Stamford or Albany, this difference could not be attributed to differential exposure to MTBE since the post-shift MTBE blood concentrations in the Fairbanks and Stamford occupational cohorts were similar.

Taken together, the findings of the Alaska study and the related studies in Stamford and Albany do not support an association between oxygenated fuel exposure and acute health effects.

Rather, they suggest the importance of evaluating the role of gasoline exposure, independent of the addition of MTBE, and increased public awareness or expectation as factors influencing the perception of an association between oxygenated gasoline and acute health complaints.

New Jersey. This study[42] compared the prevalence of target health complaints in workers in state-operated garages in northern New Jersey, where an oxygenated fuels program was in effect, to that of workers in southern New Jersey, where the oxygenated fuels program had ended several months earlier. Members of these cohorts had high potential exposure to gasoline based on their occupation; based on their location in the state, the two cohorts were likely to differ substantially in their exposure to oxygenated gasoline. Standardized questionnaires were used to determine overall symptom prevalence and the difference in symptoms for each worker post-shift compared to pre-shift.

Workers in the north did not report any increases in symptom prevalence compared to workers in the south, even when the analysis was limited to those with the highest potential gasoline exposure (based on a self-reported average of 5 or more hours per day pumping gasoline). In both the north and the south, workers reported significantly more symptoms at the end of the work shift compared to the beginning of the shift. However, there was no difference between the north and south in this analysis, suggesting that the effect was not specifically due to exposure oxygenated gasoline. Among possible explanations for the post-shift increase in symptoms in both cohorts was exposure to gasoline, independent of the presence of oxygenate.

Wisconsin. This was the first study[43] to examine the relationship between health complaints and exposure to reformulated gasoline. The study was undertaken in response to numerous citizen complaints of adverse health effects following the introduction of RFG in the Milwaukee area. A random digit dial study design was used to compare symptom prevalence, based on responses to a standardized questionnaire, in individuals from each of three areas; in two of the areas RFG was in use. In one (Milwaukee), there was extensive public resistance to RFG and adverse media coverage; in the other (Chicago), there had been no adverse public response to RFG. The third area (non-Milwaukee Wisconsin) used conventional gasoline.

The prevalence of each symptom included in the survey, including some not previously associated with oxy-fuels, was significantly higher in Milwaukee than in Chicago or non-Milwaukee Wisconsin. In Milwaukee, symptom prevalence did not increase with increasing exposure when average commuting time was used as a semi-quantitative surrogate for exposure. There were no differences between Chicago and non-Milwaukee Wisconsin in the prevalence of any symptom. Thus, while this study confirms a high prevalence of symptom reports in Milwaukee in a randomly selected population, the non-specificity of the symptom associations, lack of

an exposure-response relationship, and comparison to the other study groups suggests that the response in Milwaukee was not causally related to RFG exposure.

Causality analysis

The synthesis of the experimental and epidemiologic data discussed in the preceding sections is based on an adaptation of the principles set forth by Evans.[44] These general guidelines have been widely applied in the evaluation of putative causal relationships between environmental exposures and disease, and are adapted here to the situation where exposure is poorly defined and effects are subjective and non-specific. Accordingly, the following criteria should be met if exposure to oxy-fuels in general—or MTBE specifically—causes health disturbances in the general population:

Epidemiological studies should establish an association between exposure to oxy-fuels and self-reported symptoms or objective health findings. Clearly, none of the epidemiologic studies establishes such an association. Although each of the studies used a different approach, all are retrospective in design. Recall bias in the reporting of symptoms is a significant concern, especially since in many of the study locations oxy-fuels had received a great deal of public attention. The potential significance of recall bias is demonstrated by the marked differences in symptom prevalence in the Milwaukee and Chicago cohorts, which experienced comparable exposure to RFG, but differed in their awareness of the public controversy concerning oxy-fuels.

Another significant limitation of the studies is the lack of adequate exposure data. lisle exposure definition used in all of the studies was based on place of residence or employment of the subject, and is likely to be a source of non-differential exposure misclassification. Furthermore, while this definition encompasses the complex mixture of chemicals associated with evaporative and exhaust emissions from oxy-fuels, a more restricted definition that limits the analysis to the toxicologically significant exposure(s) would increase the ability of the study to detect effects, if there are any.

In spite of the limitations of the epidemiologic studies, they do address the concerns raised by anecdotal reports that exposure to the fuel and/or MTBE was causing widespread health disturbances in the general population. If a large segment of the population were, in fact, being affected, as has been suggested, the reported studies had a very good chance of detecting the effect. Table II, which presents the results of power calculations for several of the key symptoms, illustrates this point for the assumption that the use of oxy-fuels caused a twofold increase in symptom prevalence. For example, if the prevalence of headaches were doubled in Stamford compared to Albany, studies of comparable size would detect a statistically significant difference (at a = 0.05) 99 percent of the time.

The response to exposure to oxy-fuels should follow a logical biological gradient from moderate to severe depending upon dose. Some of the epidemiologic studies employed exposure metrics to examine dose-response relationships. Symptom prevalence was independent of the amount of time spent in an automobile[36] or commuting.[43] On the other hand, both the Alaska[33 34] and Stamford[33] studies reported an increase (statistically significant in Stamford only) in the presence of one or more key symptom in occupationally exposed subjects with MTBE blood levels in the upper quartile compared to other workers. However, subjects with the greatest exposure to MTBE tended to have the greatest exposure to other volatile gasoline components as well, and the response could reflect an effect of gasoline exposure, independent of the addition of the oxygenate. This explanation is consistent with the finding in the New Jersey study[42] that workers had an increase in post-shift symptoms compared to pre-shift, but that this increase was unrelated to whether or not the gasoline they were exposed to contained MTBE.

The quantitative extent of exposure necessary to cause any specific effect should be normally distributed for the population. While this has not been tested formally, the anecdotal experience is clearly inconsistent with this principle. Health complaints have not been reported in most areas where oxy-fuels have been used, rather only in localized areas of the country. Such marked differences in the distribution of complaints is unlikely to be explained by differences in microenvironmental and/or ambient levels of gasoline emissions or exposures.

The temperal relationship between exposure and symptoms should make biological sense and be normally distributed for the population. No data have been collected on the timing of the appearance of symptoms following exposure to, or introduction of, oxy-fuel in an area, or on the distribution of response in the population.

The effects should be replicated in appropriate experimental exposure models in animals or man. The effect of exposure to oxy-fuels has not been adequately examined in experimental studies, either animal or human. However, the effects of

MTBE exposure have been carefully examined. In animal studies, MTBE can be an ocular, sensory and respiratory tract irritant and have CNS effects at concentrations many orders of magnitude higher than those experienced in association with the use of oxy-fuels. Humans experimentally exposed to MTBE at concentrations comparable to and in excess of those experienced as a result of the use of MTBE in oxy-fuel did not have eye or nose irritation or CNS effects attributable to MTBE, as measured using objective tests for these endpoints.

Discontinuation of oxy-fuel use should decrease the incidence of the symptoms associated with its use. The only study that addresses this is the Alaska study in which the prevalence of all symptoms was found to be significantly less after the oxy-fuel program ended than during the program. In fact, the prevalence of symptoms measured after cessation of the program was considerably less than reported in any of the other studies, including the Albany study,[41] where oxy-fuels were not in use. Given the extent of public resistance to the oxy-fuel program in Alaska, the difference in symptom prevalence is likely to be influenced by recall bias.

All of the relationships and findings should make biological and epidemiological sense. The anecdotal reports of adverse health effects associated with oxy-fuels have tended to occur in clusters, a phenomenon that is not usually associated with a toxicological mechanism of action. Based on what is known about the exposure-response characteristics of the effects of MTBE in humans and animals, exposure to this chemical, associated with its use in oxy-fuels, would not be expected to cause adverse health effects in the general population. Nor would it be predicted that adverse health effects would be caused by qualitative or quantitative changes in oxy-fuel emissions, compared to conventional gasoline.

Discussion

Questions about the possible acute health effects of oxygenates (particularly MTBE) in oxyfuels are based on anecdotal reports of transient, non-specific health complaints, which occur with apparently high frequency in a minority of communities using these gasolines. Both experimental and epidemiological approaches have been used to examine the hypothesis that there is a causal relationship between MTBE and/or oxy-fuels and acute health complaints. These studies do not establish a plausible basis for expecting that oxy-fuels or MTBE will cause adverse health effects, and the epidemiologic studies have consistently failed to find a causal association between exposure to oxy-fuels and adverse health effects. On this basis, it clearly can be concluded that a causal relationship between oxy-fuel use and adverse health effects in the general population is not very plausible and has not been established.

In view of the concerns that have been raised about the health effects of oxy-fuels and MTBE, and the extent of exposure in the general population, it is important to extend the analysis to consider the likelihood that a causal relationship exists in spite of the lack of supporting data currently available. This judgment relies on an analysis of the completeness and quality of the available data, and consideration of alternate explanations for the claimed association between oxy-fuels and adverse health effects.

There are sufficient toxicologic and exposure data available for MTBE, the oxygenate used in most of the oxy-fuel sold in the U.S., to conclude that exposure to MTBE, resulting from the use of oxy-fuels, is well below the threshold for toxicity. There is less information on the effect of oxygenates on exposures to other chemicals that comprise gasoline evaporative and exhaust emissions. Based on what is known, or reasonably expected, however, it appears unlikely that toxicologically significant exposures will occur.

The most significant data gap is the absence of studies on evaporative and exhaust emissions of oxy-fuel mixtures themselves. There exists the possibility of synergistic effects within the emissions mixture that will not necessarily be predicted based on existing knowledge. There is also the potential that evaporative or exhaust emissions of oxy-fuels contain novel chemicals or chemical mixtures that are toxicologically significant. The fact that no such compounds or mixtures have been identified to date does not necessarily mean that they do not exist.

The deficiencies in the experimental data are at least partially compensated for by the existence of epidemiologic studies of populations exposed to the emissions mixtures that result from the use of oxy-fuels. The epidemiologic studies vary in quality, but complement each other In they use different approaches to assess the association between oxy-fuels and symptom prevalence. Most of the studies had sufficient power to detect effects if they were occurring in a large segment of the population; that is, an effect on the order of that suggested by the anecdotal reports.

It is possible that the epidemiologic studies are not detecting a small subpopulation of uniquely sensitive individuals who are experiencing symptoms. The

anecdotally reported symptoms are nonspecific, transient, and consistent with subjective complaints that are reported in subpopulations of individuals in response to a variety of consumer products, chemicals and odors. The scientific community continues to debate whether subjective symptoms of this type, reported in response to very low concentrations of chemicals, represent a toxicological or psychological (i.e., somatoform) response.

The Wisconsin study [43 45] examined risk factors for sensitivity to RFG. In the first phase of the study having had a cold or flu and being aware of RFG issues were strong predictors of symptoms reported to be associated with gasoline. Phase II of the study compared individuals ("health contacts") who called government agencies to report health complaints that they associated with RFG to the randomly selected Phase I subjects. Again, having had a cold or flu and being aware of RFG issues predicted symptoms in the health contacts. In addition, the health contacts were more likely to have doctor diagnosed allergies, in the absence of asthma, and be older compared to the individuals surveyed in the random digit dial part of the study. The New Jersey garage worker study [42] also reported that older individuals reported more symptoms, although this was found to be a function of their preexisting health status rather than oxy-fuel exposure.

In a survey of subjects with multiple chemical sensitivities, the increase in symptoms associated with gasoline stations and driving were comparable to the increase associated with other settings such as shopping malls, grocery stores and office buildings.[46] Based on this small study, oxyfuels do not appear to represent a uniquely significant problem for individuals who are reportedly sensitive to low concentrations of diverse chemicals.

The judgment as to the likelihood of a causal relationship between oxy-fuel exposure and adverse health effects also includes consideration of other explanations for the health complaints that have been associated, anecdotally, with oxy-fuel use. The types of symptoms reported in association with oxy-fuels are quite common and can have numerous causes, infectious, toxicologic and constitutional. A bias toward reporting these symptoms and/or attributing them to oxy-fuel exposure can be introduced in areas where the possible adverse health effects of oxy-fuels have received public and media attention.[47] Support for this possibility comes from the Wisconsin study,[43] which found that awareness of RFG issues was a predictor of symptoms in the Milwaukee area. Reporting bias secondary to media reporting could also explain why symptom prevalences were so much higher in the Alaska study [33] then in the Stamford study.[33]

The fact that the odor of oxy-fuels is different from that of conventional gasoline [1] can also play a role in the symptom associations that have been reported. The change in odor is likely to make individuals more aware of the routine exposure to gasoline that occurs in some microenvironments, and more aware of transient symptoms caused by gasoline exposure. Odor perception has been reported to correlate both with symptom prevalence and environmental concerns in individuals living near hazardous waste sites, suggesting the possibility that the perception of odor triggers stress-related symptoms or increases an individual's awareness of existing symptoms.[48]

Taken together, the experimental and epidemiologic findings support a high degree of confidence in the conclusion that MTBE-containing oxygenated and reformulated gasolines are not the cause of acute toxicity in the general population. This conclusion is further strengthened by the existence of plausible alternative explanations for the health complaints reported in association with the introduction of oxy-fuel or RFG in some communities.[2]

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TABLE I. COMPARISON OF THE CDC STUDIES: FAIRBANKS, STAMFORD, ALBANY

	Occupational Exposure			Commuters	
Symptom	Fairbanks (n=18)	Stamford (n=105)	Albany (n=82)	Stamford (n=59)	Albany (n=182)
Headache	72%	27%	37%	25%	24%
Eye irritation	67%	13%	NR	19%	NR
Nose/throat burning	50%	7%	5%	7%	13%
Cough	28%	10%	21%	15%	20%
Nausea	33%	1%	6%	-0-	8%
Dizziness	44%	6%	11%	2%	3%
Spaciness	33%	6%	2%	3%	7%

NR: not reported

TABLE II. PROBABILITY THAT EPIDEMIOLOGIC STUDIES COULD DETECT A TWO-FOLD INCREASE IN SYMPTOMS[1]

		Symptom		
Study	Comparison[2]	Headache	Eye Irritation	Cough
CDC	Stamford/Albany	0.99	ND[3]	0.70
New Jersey	North/South	0.99	0.99	0.92
Wisconsin	Chicago/Wisconsin[4]	0.69	0.48	ND

[1] Oxy-fuel exposed compared to unexposed population, $\alpha = 0.05$.
[2] Exposed cohort/Comparison cohort (no oxy-fuels program).
[3] Symptom data not reported.
[4] Wisconsin refers to non-Milwaukee Wisconsin (no RFG program).

STATEMENT OF GARY PATTON, GENERAL COUNSEL, PLANNING AND CONSERVATION LEAGUE

My name is Gary Patton. I am delighted to be here today, and want to thank you for inviting me to testify at this important hearing, inquiring into the many issues related to water pollution by the gasoline additive methyl tertiary butyl ether (MTBE). Your involvement in these issues is very much welcomed and appreciated.

I am the General Counsel of the Planning and Conservation League, a statewide environmental advocacy organization. The Planning and Conservation League is a non-profit and non-partisan statewide alliance of individual citizens and conservation organizations. Located in Sacramento, PCL is the oldest environmental lobbying group in California. For over thirty years, PCL has played a key role in virtually every significant legislative effort affecting the environment, and PCL has also been successful in passing a number of environmentally beneficial statewide initiative measures. The State legislature has recognized PCL's leadership in a resolution that states that PCL " . . . has been instrumental in the passage of every major piece of environmental legislation in California."

As you undoubtedly know, both national and State environmental organizations, including PCL, have strongly supported the "Cleaner Burning Gas" program implemented by the California Air Resources Board. This program is founded on fuel

specification regulations promulgated by the ARB, and has required the development and use of a special blend of reformulated gasoline in this State. California's "Phase 2" reformulated gasoline regulations became effective in early 1996, and have resulted in very significant air quality improvements and have also resulted in the widespread use of MTBE as a fuel additive. MTBE now amounts to about 11 percent by volume of virtually all the gasoline fuel sold in California.

I served, on behalf of PCL, on a broadly based ARB advisory committee that provided oversight of the implementation of the California "Phase 2" reformulated gasoline" program. PCL was also actively involved in the legislation passed in the State legislature earlier this year, relating to MTBE.

There is no doubt, in my opinion, that the reformulated gasoline now being used in California is truly "cleaner burning." ARB figures say that smog-forming emissions from motor vehicles have been reduced by 15 percent, because of the deployment of Phase 2 Reformulated gasoline. This is equivalent to having removed 3.5 million vehicles from the road. The California "Cleaner Burning Gas" program is the single most effective smog reduction measure since the introduction of the catalytic converter. California RFG also produces fewer cancer-causing emissions. ARB calculations demonstrate an overall reduction in carcinogenic risk of about 40 percent, due to the change in the gasoline formulation required by the California Phase 2 reformulated gasoline regulations. In fact, the health benefits of California's reformulated gasoline are significant.

Unfortunately, the analysis utilized when California's Phase 2 reformulated gasoline program was mandated made what has turned out to have been an unfounded assumption. It was assumed, because MTBE has been utilized as a gasoline additive for many years (though in small quantities), that changing the formulation of gasoline to replace about 11 percent of the benzene in gasoline with MTBE would not change any of the characteristics of the gasoline except those related to air emissions. This assumption was wrong.

A "success story" on the air quality side, MTBE is anything but a success story when water pollution is considered. Your hearing agenda today indicates that you are studying "possible" water pollution by MTBE. This is too charitable. There is no doubt that significant instances of MTBE-related water pollution have occurred in various locations throughout California, and that further and serious pollution incidents are probably inevitable. MTBE moves rapidly through soil and groundwater in a way that is different from the way that other components of gasoline move. Any gasoline leak is serious, and potentially a danger to human health and the environment. Unfortunately, leaks of gasoline containing MTBE are more serious than other gasoline leaks and not because MTBE is more carcinogenic or dangerous than benzene (in fact, there is evidence that MTBE is safer than benzene, which is highly carcinogenic). The problem is the rapid deployment of MTBE in soil and groundwater, which leads to a more difficult clean up situation, and the fact that MTBE contamination makes water unusable for drinking water purposes when even minute amounts of MTBE are present, because of odor and taste problems.

PCL is greatly concerned with the water contamination problems associated with MTBE, which is why we supported the three pieces of State legislation enacted last year, SB 1189 by Senator Tom Hayden, AB 592 by Assembly Member Sheila Kuehl, and SB 521 by Senator Richard Mountjoy. Both the Hayden and Kuehl bills mandate that a primary and secondary drinking water standard for MTBE be developed, and they mandate improvements in pipeline and underground tank safety programs. Senator Mountjoy's bill in its final form requires a study of the comparative study of the human health and environmental risks and benefits, if any, associated with the use of MTBE in gasoline, as compared to other possible additives, including ethanol. The study mandated by SB 521, as you undoubtedly know, is to be completed in early 1999. Based on the final document, incorporating comments from the public and relevant State and Federal agencies, the Governor must make a certification either that "on balance, there is no significant risk to human health or the environment of using MTBE in gasoline" or that there is a significant risk. If the Governor determines that there is a significant risk, he is directed to implement appropriate action in response to his finding. Clearly, this could result in the prohibition of the further use of MTBE in gasoline.

PCL did not support the early version of SB 521, which would have "banned" MTBE effective immediately. As stated, however, we do believe that a thorough, but rapid, study is called for, and that it may well be advisable, when the results of that study have been received, to take action that will result in the elimination of MTBE from California gasoline.

Is there, in the meantime, something we can do and that you and the Congress can do? Yes.

All gasoline leaks into soil and groundwater are dangerous to the public health and the environment. Both State and Federal requirements can be tightened.

Alternative oxygenates should be made available. It is time to begin seriously considering the use of ethanol, which, while it has a number of potential problems, also has many positive features that make it an attractive substitute for synthetic oxygenates like MTBE.

We will use less gasoline, and thus pollute the air less, and expose groundwater to less risk, to the degree that we can transition to non-petroleum transportation fuels. We will also achieve these positive results to the degree that we can

increase fuel efficiency and substitute transit and rail transportation for transportation based on the single occupancy auto. The Federal Government can play a key role in achieving all of these ends, and I encourage you and your colleagues to pursue them. In fact, we need longer term, fundamental strategies for reform. By achieving such long term and fundamental reforms, we can generate a positive outcome from the genuine public health and environmental crisis occasioned by the water pollution incidents involving MTBE that are now occurring throughout California, and that we must assume will continue to occur.

Thank you again for allowing me to testify here today.

HEALTH HAZARDS FROM EXPOSURE TO MTBE IN WATER

(By Myron A. Mehlman, Ph.D.)

QUALIFICATIONS

I received a Bachelor of Science in chemistry from City College of New York in 1957 and a Ph.D. from Massachusetts Institute of Technology in 1964. I undertook further study as a Post-doctoral Fellow in biochemistry at the Institute for Enzyme Research, University of Wisconsin (1967). In 1974, I completed the Program for Health Systems Management at Harvard Business School.

Presently, I am an Adjunct Professor of Environmental and Community Medicine at University of Medicine and Dentistry of New Jersey—Robert Wood Johnson Medical School in Piscataway, New Jersey. My current research includes the study of asbestos exposure in the petrochemical and oil refining industries, toxicology of gasoline, methyl tertiary butyl ether ("MTBE") and also studies of solvents and environmental toxicants in general. I am also an Adjunct Professor of Medicine at the Mt. Sinai School of Medicine in New York City, a faculty member of New York University Medical School, and a Visiting Professor of Industrial and Environmental Toxicology for Department of Pharmacology and Toxicology, Rutgers College of Pharmacy, Rutgers University, New Jersey.

From 1977 to 1978, I served as Director of Environmental Health and Toxicology for Mobil Oil Corporation. In this capacity, I monitored exposures of toxic and carcinogenic chemicals and gases in chemical plants and refineries, and developed health and safety procedures.

From 1978 to 1989,1 held the position of Director of Toxicology and Manager of Environmental Health and Science Laboratory in the Department of Environmental Affairs and Toxicology for Mobil Oil Corporation. I was responsible for the Environmental and Health Sciences Laboratory, which consisted of a staff of over 100. My responsibilities as Director involved testing, methods development, and evaluation of the toxicity and carcinogenicity of various chemicals and petroleum products. Under my direction, extensive multidisciplinary testing was conducted on potential environmental hazards. The disciplines involved included: toxicology, ecotoxicology, biochemistry, carcinogenesis, genetic toxicology, environmental chemistry, pathology, reproductive toxicity, pharmokinetics, metabolic evaluation, dermotoxicity, and analytical chemistry.

I have held many positions in the areas of environmental health and toxicology with the United State government. From 1991–1994, I held the position of Visiting Scientist for the Agency for Toxic Substances and Disease Registry, Public Health Service, and the Department of Health and Human Services. In this capacity, I conducted research on the carcinogenesis and toxicology of petroleum chemicals.

In addition, I was the Interagency Liaison Officer for the Office of Director at the National Institutes of Health ("NIH"). I also served as the Special Assistant to the Associate Director for Program Planning and Evaluation at NIH. In these capacities, I dealt with environmental policies and toxicological testing of chemicals and environmental pollutants. This work involved large-scale evaluation programs regarding proper procedures for productions, use and disposal of toxic and cancer-causing chemicals. Health agencies falling within these policy guidelines included

NIH, National Institute of Environmental Health Sciences, Centers for Disease Control and Prevention, National Institute of Occupational Safety and Health, Food and Drug Administration, National Toxicology Program ("NTP"), Consumer Products Safety Commission, Department of Energy, and the U. S. Environmental Protection Agency ("U.S. EPA"). I was the Special Assistant for Toxicology, Nutrition, and Environmental Affairs in the Office of the Assistant Secretary for Health of the Department of Health, Education and Welfare. In addition, I was Chief of Biochemical Toxicology, Bureau of Foods at the Food and Drug Administration. Furthermore, at the Department of Health, Education and Welfare, I served as the executive secretary to the Committee to Coordinate Toxicology and Related Programs.

I am actively involved in several professional organizations. For example, I am a founding member and past president of the American College of Toxicology and a member and past president of the International Society of Exposure Analysis. In addition, I am currently the Secretariat for North America and a member of the Executive Council of the Collegium Ramazzini.

I am also a member of the New York Academy of Science; Society of Risk Analysis; Society for Experimental Biology and Medicine; Society of Toxicology; Air Pollution Control Association; American College of Nutrition; American Chemical Society (Division of Biological Chemistry and Medical Chemistry); American Society for Pharmacology and Experimental Therapeutics; American Physiological Society; American Institute of Nutrition; and American Society for Biological Chemists. On behalf of Mobil Oil Corporation, I was also a member of the Chemical Industrial Institute of Toxicology ("CIIT").

Moreover, I serve and have served on editorial boards of number of professional publications, I was the editor of the Journal of Toxicology and Environmental Health and the Journal of Environmental Pathology and Toxicology, the official publication for the American College of Toxicology. I also serve on the editorial boards of Environmental Research, Journal of Clean Technology, Environmental Toxicology, and Occupational Medicine, Journal of Exposure Analysis and Environmental Epidemiology, and Toxicology and Industrial Health. I was the series editor for Advances in Modern Nutrition, Advances in Modern Toxicology, and Symposium of Metabolic Regulation, and I am currently the series editor of Advances in Modem Environmental Toxicology.

OPINIONS

My opinions are based, in part, on the studies and analysis contained in this report.

Based on the currently available cancer studies, it is my opinion that MTBE is a probable human carcinogen. Moreover, I further opine that in order to reduce or prevent unnecessary risks of developing cancers, exposure levels in drinking water should not exceed 5 parts per billion ("ppb"). My opinion is based on the following:

1. It is an accepted scientific principle that when a chemical is shown to cause cancers in different species of experimental animals, it is considered probable human carcinogen. MTBE has been shown to cause cancers in two different species of experimental animals in three separate studies.

2. When a chemical is shown to cause cancers in experimental animals and/or in humans, the levels to which humans can be exposed are set extremely low by State and Federal Governments, even though there is really no safe level above zero for a carcinogen. This means that some humans who are exposed to MTBE, even at extremely low levels, may develop cancers, especially pregnant women, young children, and sensitive individuals.

3. Since MTBE has been shown to cause cancers similar to that of benzene, a known human carcinogen, it is prudent to set drinking water levels at 5 ppb or less.

DISCUSSION

A. Studies on MTBE

It is my opinion that MTBE can cause cancers in humans. Specifically, studies in at least three different laboratories have demonstrated that MTBE causes cancer in rats and mice. These cancers include leukemia and lymphomas, testicular cancer, kidney cancer, and liver cancer.

Further, MTBE causes cancers in many organs and tissues of two species of experimental animals, and these cancers are identical to those caused by exposures at the same doses as benzene, vinyl chloride, and 1,3-butadiene, which are known human carcinogens. My opinion is supported by the general agreement among experts in chemical carcinogenesis that a substance which causes cancer in significant numbers of experimental animals in well conducted assays poses a presumptive carcinogenic risk to some humans, even in the absence of confirmatory epidemiological

data. Even though there is no recognized method as yet for establishing the existence of a threshold for a carcinogen in the human population; these principles, which are accepted by scientific and medical experts throughout the world, have served for many years as the basis for sound public health policy and regulatory action on carcinogens.

For example, the International Agency for Research on Cancer ("IARC") of World Health Organization with input from hundreds of world-renown scientists, set forth the following principle:

Information compiled from the first 41 volumes IARC monographs shows that, of the 44 agents for which there is sufficient or limited evidence of carcinogenicity to humans, all 37 that have been tested adequately experimentally produce cancer in at least one animal species . . . .Thus, in the absence of adequate data on humans, it is biologically plausible and prudent to regard agents for which there is sufficient evidence of carcinogenic risk to humans. (IARC Monograph, Supplement 7, 1987)

B. Carcinogenic Effects of MTBE

Furthermore, I am of the opinion that MTBE causes cancers. Specifically, in chronic-inhalation studies of MTBE, the two highest exposure concentrations (3,000 and 8,000 parts per million ("ppm") resulted in an excessive number of deaths (ARGO, 1993). It was suggested (memo to the U.S. Environmental Protection Agency) that MTBE-induced kidney disease was responsible for the deaths in both mice and rats. Uropathy[1] was the term coined for the findings in mice, but pathological examination suggested that kidney effects were not the major cause of the deaths among mice. Chronic progressive renal[2] disease was reported in all doses in the male rats, and in the higher two doses among females. There was also an increase in kidney tumors in males, and one incidence of kidney tumor in the females. Despite the fact that renal lesions were identical in both males and females, the author of the study claimed that aμ,2globulin[3] was involved. The U.S. EPA's guidelines on this matter emphasize that this type of nephrotoxicity[4] occurs only among some strains of male rats (U.S. EPA, 1991; Melnick, 1992, 1993; ARCO, 1993).

1. MTBE Should Be a Class B Carcinogen

MTBE should be a Class B carcinogen. Nevertheless, the U.S. EPA misclassified MTBE. By promising conclusive evidence that was to be based on ongoing research, the oil industry convinced the U.S. EPA that this protein was the cause of the renal toxicity. Some of these reports were promised as late as April 1993. The U.S. EPA report (U.S. EPA, 1993) implied that the kidney toxicity and tumors were due to aμ,2globulin. The report noting the failure of the kidneys to stain appropriately for aμ,2globulin was submitted to the U.S. EPA by the oil industry task force in their November 5, 1993, Section Be submission. However, the U.S. EPA was aware of these facts prior to this time. In August 1993, an expert on aμ,2globulin, from CIIT, investigating the possible role of this protein on the MTBE-rat nephropathy[5] informed U.S. EPA management that the slides did not stain for aμ,2globulin. This misinformation above lead the U.S. EPA to classify MTBE as a Class C carcinogen rather than a Class B carcinogen, thus exposing humans to an increased risk of cancer from MTBE.

2. Increases in Testicular Tumors

There was also an increase in testicular tumors in male rats, and liver tumors in both sexes of mice (Burleigh-Flayer et al., 1992).These increases were excused as a basis for quantitative risk assessment because—in the case of the testicular tumor—the historical control-ranges were higher than concurrent controls. The rather unique argument for disregarding the mouse liver tumors, apparently being applied by the U.S. EPA only to this compound, was: "Evidence of toxicity observed at the high dose causes the human hazard significance of high-dose chemically induced mouse liver tumors to be the subject of debate." The scientific bases for this interpretation are, at best, weak.

3. MTBE Affects Fetus

The U.S. EPA did recognize that MTBE affects the fetus. However, their analysis included no data from the Biles et al. (1987) study which noted changes that were biologically, but not statistically, significant at lower concentrations than those in the U.S. EPA-selected studies. It is noteworthy that the American Conference of

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[1] Any disorder involving the urinary tract.
[2] Pertaining to the kidney.
[3] Specific protein found in kidney of male rats.
[4] The quality of being toxic or destructive to kidney cells.
[5] Disease of the kidneys.

Governmental Industrial Hygiene ("ACGIH") committee used the Biles et al. 1987 study as the basis for their proposed Threshold Limit Values ("TLVs")[6].

As with the inhalation studies, the results of these studies, reported to the U.S. EPA by ARCO on November 16, 1993 under Section Be of the U.S. EPA's Toxic Substances Control Act, showed an increase in testicular tumors. However, because gasoline also contains benzene, a potent leukemogen[7], the increase in leukemia, Leydig[8] cell tumors, and lymphomas may be of greater significance (Infante et al., 1977; infants and White, 1985). Therefore, we now have the potential for additive effects of two leukemogens in gasoline. Why these results were not discussed in the U.S. EPA report (U.S. EPA, 1993) is unusual since Section Be was listed in the references.

4. Further Studies that Support Carcinogenic Effects

In October 1993, at a meeting sponsored by Collegium Ramazzini in Carpi, Italy, Professors Maltoni and Belpoggi reported their findings in experimental studies, as shown in Table 1 below. The results of all animal carcinogenicity studies on MTBE are summarized in Table 2. To date, the weight of evidence clearly provides sufficient data to conclude that MTBE and its metabolites—formaldehyde and tertiary butyl alcohol ("TBA")—are animal carcinogens.

TABLE 1. Results of Carcinogenicity Study In Sprague Dawley Rats

Cancer Type	Control	250 mg/kg	1,000 mg/kg
Combined lymphoma and leukemias	3.4 percent	11.8 percent	25.5 percent
Testicular Leydig cell tumors	7.7 percent	8 percent	34.4 percent

Source: Belpoggi et al. (1995). Toxicol. Ind. Health. 11(2). pp. 119–150.

TABLE 2. Weight of Evidence for Carcinogenicity of MTBE

Animal	Organ	Statistically Significant	Sources
Rat	Kidney Tumor	Yes	ARCO, 1993
Male Rat	Testes Tumor	Yes	ARCO, 1993 Belpoggi et al., 1995
Female Rat	Lymphoma and Leukemia.	Yes	Belpoggi et al., 1995
Male Mouse	Liver	Yes	ARCO, 1993
Female Mouse	Liver	Yes	ARCO, 1993

Mehlman (1996) summarized the weight of evidence for carcinogenicity for MTBE. The weight of evidence available to date clearly provides sufficient data to conclude that MTBE and its metabolites—formaldehyde and t-Butyl alcohol—are carcinogenic in animals.

TABLE 3. Weight of Evidence for Carcinogenicity for MTBE

Animal	Organ	Statistically Significant
Male rat	Kidney tumor	Yes
Male rat	Testes tumor	Yes
Female rat	Lymphoma and leukemia	Yes
Male rat	Hemolymphoreticular tumors	Yes
Male mouse	Liver	Yes
Female mouse	Liver	Yes

C.B. Hirmath and J.C. Parker in a U.S. EPA publication entitled "Methyl Tertiary Butyl Ether: Cancer Risk Assessment Issue" from the Office of Research and Development, U.S. EPA, Washington, DC summarized scientific citation for cancer studies as follows:

[6] TLVs refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect.

[7] Any substance or entity considered to be a causal factor in the occurrence of leukemia.

[8] Cells which are found in the testes.

TABLE 4. Weighing the Evidence for MTBE

Animal	Organ	Statistical Significant	Isues
Male rat	Kidney	Yes	Yes
Male rat	Testes	Yes	Yes
Male mouse	Liver	Yes	Yes
Female mouse	Liver	Yes	Yes

Increased tumor incidences reported in second study by different route of administration.
Two metabolites (formaldehyde and t-Butyl alcohol) show carcinogenic activity in animals.

C. Exposure Limits for MTBE

1. State Regulation and Guidelines for MTBE in Drinking Water It is my opinion that the State guidelines at the present time are misleading. More specifically, the State guidelines and standards (listed below) were developed prior to conducting any adequate toxicological testing on MTBE, and as a result, there was little or no data available regarding the safety of MTBE. In fact, cancer data was not even available until 1993–1995.

TABLE 5. Regulations and Guidelines Applicable to Methyl Tertiary Butyl Ether (MTBE): State Regulations and Guidelines (Water)

State	Water Quality: Human Health	Information	Reference
AZ	Domestic/Drinking H2O ..	351 μg/l	Sittig 1994
CT	Drinking H2O Guidelines	100 μg/l	FSTRAC 1990
MA	Drinking H2O Guidelines	50 μg/l	FSTRAC1990
ME	Drinking H2O Guidelines	50 μg/l	FSTRAC 1990
NH	Drinking H2O Guidelines	200 μg/l	FSTRAC 1990
RI	Drinking H2O Guidelines	50 μg/l	FSTRAC 1990
VT	Drinking H,0 Guidelines	40 μg/l	FSTRAC 1990

Source: Toxicological Profiles
Note: FSTRAC, Federal State Toxicology and Regulation Alliance committee.

In the absence of toxicological or cancer data, the exposure level for systemic effects are set at 10 to 100 fold lower. However, when cancer data is available, as in the case of MTBE, the drinking water level should be set between 1 to 5 υg/l which is the case for other carcinogens.

As noted heretofore, the above standards and guidelines were set prior to the availability of cancer studies. It is now clear that there is sufficient evidence for carcinogenicity for MTBE in experimental animals. MTBE, which is comparable to benzene (a known human carcinogen), causes cancers at approximately the same concentrations as benzene does. Therefore, the occupational and environmental exposure levels for MTBE should be same as that for benzene which the U.S. EPA sets at 5 ppb for ambient air and water permissible exposure levels. The following discussion of benzene serves to illustrate the current state of scientific knowledge as to the carcinogenicity of benzene in experimental animals and humans.

D. Benzene: A Human Carcinogen

Benzene, a significant component of gasoline and other petroleum products, is widely recognized as a carcinogen in both animals and humans (Poklis and Burkett, 1977; Mehlman, 1983, 1985, 1989, 1990; U.S. EPA, 1984, 1986). Today, total benzene usage is approximately 11 billion gallons per year (ACGIH, 1990); it has been estimated that 238,000 people are occupationally exposed to benzene in petrochemical plants, petroleum refineries, and other operations. More than 90 percent of the benzene produced in the United States is manufactured from petroleum sources. Benzene is currently classified by the U.S. EPA and IARC as a human carcinogen.

1. Benzene-Caused Cancers in Animals. In numerous studies, Maltoni and Scarnato (1979) and Maltoni et al. (1982a,b,c, 1983a,b, 1985, 1987) demonstrated that benzene caused tumors in rats and mice, including cancer of the zymbal gland, oral cavity, lung, skin, nasal cavity, forestomach, harderian gland, mammary gland, preputial gland, ovary, and uterus; hepatomas; angiosarcoma of liver; hemolymphoreticular neoplasia; lymphoma; and all types of leukemias (Table 6). Huff et al. (1989) expanded these studies using a broader dose-range, reporting numerous cancers occurring at a lower dosage in various organs and tissues (Table 6). These types of reports such as Maltoni et al. and Huff et al., are well-known, published, reliable scientific reports which experts in the scientific community rely upon to support their opinions and conclusions.

2. Earlier Knowledge of Benzene Causation of Leukemias. The earlier data on benzene-caused carcinogenicity in humans were based on a number of clinical cases of leukemias in humans occupationally exposed to benzene. The 1928 report by Delore and Borgomano and the 1932 report by Lignac were followed by a variety of reports from Italy (Vigliani and Saita, 1964; Vigliani, 1976), France (Goguel et al., 1967; Girard et al., 1968, 1970), and Turkey (Aksoy et al., 1972,1974). Goldstein (] 977), in a comprehensive review of the literature on benzene, compiled case reports on benzene-exposed individuals with hemolymphoreticular cancers. The types of leukemias found in these individuals included: acute myelogenous leukemia, erythroleukemia, acute myelomonocytic leukemia, chronic myelogenous leukemia, myelofibrosis and myeloid metaplasia, thrombocytopenia, acute lymphoblastic leukemia, chronic lymphocytic leukemia, lymphomas, and other related cancers. As previously noted, these types of studies listed above are frequently relied upon by experts as the bases of their opinions.

TABLE 6. Cancers Caused by Benzene Exposure in Rats and Mice

RATS [1]	MICE [2]
Zymbal gland	Zymbal gland
Oral cavity	Oral cavity
Nasal cavities	Skin
Skin	Lung
Forestomach	Harderian gland
Mammary gland	Mammary gland
Hepatomas	Preputial gland
Angiosarcoma of liver	Forestomach
Hemolymphoreticular neoplasia	Ovary
Lung	Uterus
	Leukemia
	Lymphoma

[1] Maltoni et al, 1989.
[2] Huff et al., 1989.

3. Human Leukemias and Cancers Caused by Benzene

The types of leukemias caused from exposure to benzene include: acute myelogenous leukemia, acute lymphocytic leukemia, acute erythroleukemia, acute myelomonocytic leukemia, acute promyelocytic leukemia, acute undifferentiated leukemia, hairy-cell leukemia, chronic myelogenous leukemia, chronic lymphocytic leukemia, Hodgkin's disease, non-Hodgkin's lymphoma, and multiple myeloma (Table–7). Yin et al. (1989) reported significant increases in human cancers from exposure to benzene. Benzene caused leukemia and cancers of the lung, liver, lymphosarcoma, stomach, esophagus, nasopharnyx, and intestine (Table 8). In 1946, the threshold limit value-time weighted average (TLV-TWA)[9] for benzene was 100 ppm. From then on, it was reduced as follows: 1947, 50 ppm; 1948–1956, 35 ppm; 1957–1962, 25 ppm; 1977–1987, 10 ppm; currently it is 1 ppm. In July 1990, the ACGIH recommended that the TLV-TWA for benzene be reduced to 0.1 ppm.

TABLE 7. Types of Leukemia from Benzene Exposure In Humans

- Acute myelogenous leukemia
- Acute lymphocytic leukemia
- Acute erythroleukemia
- Acute myebmonocytic leukemia
- Acute promyelocytic leukemia
- Acute undifferentiated leukemia
- Hairy-cell leukemia
- Chronic myelogenous leukemia
- Chronic lymphocytic leukemia
- Hodgkin's disease
- Non-Hodgkin's lymphoma
- Multiple myeloma

Sources: Debra and Borgomano, 1928; Goguel et al., 1967; Vigliani, 1976; Infante et al., 1977; Rinsky et al., 1981; IARC, 1982; De Coufle et al., 1983; Rinsky, 1987; Aksoy, 1989; Goldstein, 1989.

[9] TLV-TWA is the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

TABLE 8. Excess Human Cancers In Benzene Workers

• Leukemia	• Stomach
• Lung	• Esophagus
• Liver	• Nasopharynx
• Lymphosarcoma	• Intestine

Source: Yin et al. (1989).
Note: The data are from 28,460 workers (15,643 males, 12,817 females) from 233 factories and 28,257 control workers from 83 factories. Lowest average estimated level of exposure for leukemia, 6.5 mg/m^3.

In 1939, Hunter reported that benzene causes human cancers. It is my opinion, that there is no safe level of exposure to benzene. My opinion is supported by others documented reports. For example, in September 1948, the American Petroleum Institute-("API") issued a document entitled API Toxicology Review: Benzene, prepared by P. Drinker and widely circulated to oil companies. This report states, "Inasmuch as the body develops no tolerance to benzene and there is a wide variation in individual susceptibility, it is generally considered that the only absolutely safe concentration for benzene is zero."

Moreover, in further support of my opinion, in 1989 the Committee on the Evaluation of Carcinogenic Substances (Health Council of The Netherlands), in consultation with other research institutes and with the participation of industry experts, carefully conducted a health risk assessment on benzene in ambient air, based on all available human and animal data. The committee concluded, in its Integrated Criteria Document, that "chronic exposure in ambient[10] air to benzene should be limited to below 12 υg/m^3, or 4 ppb." This exposure will limit the risk of leukemia. Since we do not know of any safe level above zero, avoiding any possible exposure to benzene and benzene-containing products is desirable.

E. Comparison of Cancers Caused by Benzene and by MTBE

Results in Table 9 demonstrates that benzene-caused cancer in animals, such as kidney, liver, hemolymphorecticuiar, leukemia and lymphoma are also caused in animals exposed to MTBE. The evidence below strongly supports my opinion that the parallels between benzene and MTBE are extremely significant.

TABLE 9. Comparison of Cancers Caused by Benzene and MTBE In Animals

Cancer	Benzene		MTBE
	Animals	Humans	Animals
Kidney tumors	Yes	Yes	Yes
Leukemia	Yes	Yes	Yes
Lymphoma	Yes	Yes	Yes
Hemalymphoreticular Tumors	Yes	Yes	Yes
Liver tumors	Yes	Yes	Yes

F. Regulation Levels for Possible and Probable Human Carcinogens as a Precedent for MTBE to Be Classified as a Probable Human Carcinogen

The regulation and advisories issued by the U.S. Federal Government and individual State governments to control the levels of contaminants in drinking water vary as detailed below:

1,2-Dichloroethane
California: 1 μg/L
Connecticut: 1 μg/L
New Jersey: 2 μg/L
U.S. EPA: 5 μg/L

1,1,2,2-Tetrachloroethane
Arizona: 0.5 μg/L
Kansas: 1.7 μg/L
Vermont: 1.7 μg/L
U.S. EPA: 1.7 μg/L

1,1-Dichloroethane (vinyl chloride)

[10] Ambient defined: surrounding.

Illinois: 1 μg/L

Trichloroethylene
U.S. EPA: 5 μg/L

1,1,1-Trichloroethane
New Jersey: 26 μg/L

As a means of comparison, the regulatory levels of benzene, a known human carcinogen, are listed below.

Benzene
California: 0.7 μg/L
Connecticut, Florida, and New Jersey: 1 μg/L
Maine and Puerto Rico: 5 μg/L
U.S. EPA: 5 μg/L

As one can see from the above data, the permissible exposure levels of contaminants in drinking water for possible or probable human carcinogens are extremely low, sometimes even as low as that for a known human carcinogen, such as benzene. Thus, the standards for MTBE should at the minimum, be decreased in accordance with that of other chemicals which are classified as possible or probable human carcinogens. The following are examples of chemicals which are classified as probable or possible human carcinogens. The classification of these chemicals as probable human carcinogens is a result of reliance on information from various studies listed below. As noted heretofore, these kinds of studies are accepted throughout the scientific community.

1. Carcinogenicity of Trichloroethylene

Maltoni et al. (1986, 1988) reported statistically significant increases in lung and liver tumors in rats and mice exposed to trichloroethylene ("TCE"). These studies also report incidence of testicular Leydig cell tumors in rats, adenomas and hepatomas in male Swiss mice and lung adenomas in female B6C3F1 mice. Increases in tumors are also reported in the animal studies conducted by Fukuda et al. (1983) and Bell et al (1978).

Henschler et al. (1980) exposed mice, rats, and Syrian hamsters to TCE and found significant increases of malignant lymphomas and NTP studies (1982, 1986a) report significant increases in liver and kidney cancers in mice and rats exposed to the chemical.

In studies of humans exposed to TCE, Axelson et al. (1978, 1986a, 1986b) report significant increases in bladder cancers and lymphomas. Blair et al. (1979) found significant increases in cancers at several sites (lung/bronchus, trachea, cervix, and skin), and Barret et al. (1980) report an association between cancer and naso- and oropharynx resulting from exposure to TCE. The U.S. EPA has classified TCE as a probable human carcinogen and recommended that the maximum content level of the chemical in drinking be water 5pg/L.

2. Carcinogenicity of 1,1 Dichloroethane

In 1985, Maltoni et al. demonstrated that exposure to 1,1 dichloroethane ("DCE") causes cancer in Swiss mice. Their study reports an increase in both malignant and nonmalignant cancers in male and female mice exposed to 10 ppm to 25 ppm Cancers of the mammary glands and lung and renal adenocarcinomas and leukemias were found.

The renal adenocarcinomas are of particular interest as they are rare tumors in the Swiss mouse. Furthermore, the Maltoni et al. study reports the incidence of a variety of mammary tumors (fibroadenomas, carcinomas, sarcomas, and carcinosarcomas). Quast et al. (1988) also observed a statistically significant increase in adenocarcinomas in the mammary gland in rats exposed totally to DCE.

Results of studies of animals show increases in various malignant and nonmalignant cancers following oral or inhalation exposure to DCE, thus providing evidence that DCE is a carcinogen (Maltoni et al., 1985; Ponomarkou and Tomatis, 1980; Quast et al., 1986; Van Duuren et al., 1979). On the basis of such data the U.S. EPA has concluded that DCE is a possible human carcinogen, the category that applies to chemicals for which there is a limited evidence of carcinogenicity at the moment. However, the current weight of the evidence suggests that DCE is at least a probable human carcinogen.

G. State of North Carolina's Classification of MTBE

1. Review of Standards. Set forth below is the State of North Carolina's review and classification of MTBE as a carcinogen which was prepared by Dr. Kenneth

Rudo (the State toxicologist) and published in Toxicology and Industrial Health, Volume 11, Number 2,1995

In 1992–1993, when North Carolina held public hearings pursuant to setting a groundwater standard for MTBE, no carcinogenicity data were available for review, and citizen comments indicated that no such data existed. When the Environmental Epidemiology Section (EES) of the North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR) contacted the EPA about possible ongoing studies, the section was informed that these bioassays were not complete and that no carcinogenicity data, positive or negative, currently existed for MTBE.

Weight of Evidence of Carcinogenicity Utilized By EPA

Group A—Human Carcinogen (U.S. EPA, 1987)

This group is used only when there is sufficient evidence from epidemiologic studies to support a causal association between exposure to the agents and cancer.

Group B—Probable Human Carcinogen

This group includes agents for which evidence of human carcinogenicity based on epidemiologic studies is "limited," and also includes agents for which the weight of evidence of carcinogenicity based on animal studies is "sufficient." The group is divided into two subgroups. Usually, Group B1 is reserved for agents showing limited evidence of carcinogenicity from epidemiologic studies. It is reasonable, for practical purposes, to regard an agent with "sufficient" evidence of carcinogenicity in animals as if it presented a carcinogenic risk to humans. Therefore, agents for which there is "sufficient" evidence from animal studies and for which there is "inadequate evidence" or "no data" from epidemiologic studies would usually be categorized under group B2.

Group C—Possible Human Carcinogen

This group is used for agents with limited evidence of carcinogenicity in animals in the absence of human data. It includes a wide variety of evidence, e.g., (a) a malignant tumor response in a single well-conducted experiment that does not meet conditions for sufficient evidence, (b) tumor responses of marginal statistical significance in studies having inadequate design or reporting, (c) benign (not malignant) tumors with an agent showing no response in a variety of short-term tests for mutagenicity, and (d) responses of marginal statistical significance in a tissue known to have a high or variable background tumor rate.

Group D—Not Classifiable as to Human Carcinogenicity

This group is generally used for agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.

Group E—Evidence of Noncarcinogenicity for Humans

This group is used for agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.

The designation of an agent as being Group E is based on the available evidence and should not be interpreted as a definitive conclusion that the agent will not be a carcinogen under any circumstances.

2. Conclusion by Dr. Kenneth Judo. The following conclusion by Dr. Rudo which is set forth below supports my opinion on MTBE. In arriving at his conclusion, Dr. Rudo cites several studies which also support my findings on MTBE:

Both the Chun et al. (1992) and Burleigh-Flayer et al. (1992) studies exhibited several problem areas that must be considered when deciding if a resulting increase in tumors should or should not contribute to a weight-of-evidence decision for carcinogenicity. In each case, high doses of MTBE caused increased toxicity and mortality in the treated animals, resulting in a study lasting less than 2 years. In addition, there were high levels of spontaneous testicular tumor formation in control F344 rats (common for this strain) and the appearance of male rat kidney tumors (a possible alpha-μ2-globulin effect) in the Chun study. However, the EES feels that these studies are valid for the following reasons.

1. In the Chun study, a statistically significant increase in kidney and testicular tumors was identified in male rats. A dose response effect was evidence for the testicular tumors, even with the shortened study time (less than 24 months). The problem with a shorter study duration is that it may mask any lower dose response that may exist. In the Chun study, this was not the case unless the low-dose group was to exhibit a response at 24 months. The important point is that a clear statistically significant tumor response was detected, which decreases the negative impact of increased mortality and shorter study time. This is also true for the Burleigh-Flayer study. Both male and female mice exhibited a statistically significant increase in a

tumor response. The shortened study duration in this case may have affected the sensitivity of the bioassay, since a response was evident only in the high-dose group. As the EPA poster stated, there was no way to know if a longer exposure period would have provided a dose response (Hiremath and Parker, 1994). However, even in this study, a clear statistically significant tumor response was observed. This renders the problems of mortality and study time less important for determining if MTBE is actually carcinogenic to these animals.

2. Although control groups in male rats in the Chun study exhibited a high spontaneous background of testicular tumors, the response in two dose groups was still statistically significant when compared to the controls. This significant tumor increase, along with the observed dose response, justifies a consideration of this study as "contributing to the overall weight of evidence for MTBE carcinogenicity" (Hiremath and Parker, 1994). Further evidence of the significance of the testicular tumors as relevant to humans was provided by Belpoggi et al. (1995). They observed the formation of male rat testicular tumors in Sprague-Dawley rats (vs. the F344 rat strain utilized by Chun and coworkers), with controls exhibiting a much lower background rate of testicular tumors than found in the Chun Study. This indicates that the Sprague-Dawley rat is a better model for detecting testicular responses than the F344 rat, and also supports the testicular tumor finding by Chun et al. (1 992).

3. Information discussed earlier in this paper indicated that the male rat kidney tumor response observed in the Chun study was not related to alpha-μ2-globulin accumulation, according to criteria set forth by the U.S. EPA (1991), and that no evidence was found to indicate that MTBE causes alpha-μ2-globulin accumulation. Therefore, due to the statistically significant tumor increase, "the kidney tumors are viewed as being relevant to humans and as contributing to the overall weight of evidence for MTBE carcinogenicity" (Hiremath and Parker, 1994). Further evidence of the significance of the kidney tumors as relevant to humans was the NTP study that found an increased kidney tumor response in male rats when TBA, a major MTBE metabolite, was administered in drinking water (NTP, 1994).

4. The Burleigh-Flayer study indicated a statistically significant increase in two types of liver tumors (adenomas in female mice, carcinomas in male mice) in both sexes of CD–1 mice. From the viewpoint of the EES, these liver tumors contribute to the overall weight of evidence for MTBE carcinogenicity.

5. The Maltoni study (Belpoggi et al., 1995) has given an indication of statistically significant tumor increases in a different rat strain (Sprague-Dawley vs. F344) than that utilized by Chun et al. (1992). In addition, an increase in a different tumor type (leukemias and lymphomas) in female rats was observed, with a dose response evident, as well as the testicular tumor response observed in male rats. The information from this study adds significantly to the overall weight of evidence for MTBE carcinogenicity.

6. A major metabolite of MTBE, formaldehyde, has been shown to be mutagenic and carcinogenic in animals and probably in humans. The metabolic activation of a compound to a known carcinogen also must be considered in assessing an overall weight of evidence for MTBE carcinogenicity.

The strength of the statistically significant increase in tumors observed, dose responses, and carcinogenic responses in different rodent species and in both sexes of CD–1 mice, overcomes the problems detailed in the Chun and Burleigh-Flayer bioassay studies. It is evident from these studies that MTBE is an animal carcinogen. More work may be necessary in order to assess the carcinogenic potency and to assign a carcinogenic risk value to MTBE, but its carcinogenicity in animals has been established. MTBE causes tumors in male rats (kidney tumors in F344 rats and testicular tumors in F344 and Sprague-Dawley rats), female Sprague-Dawley rats (lymphomas and leukemias), male CD–1 mice (liver carcinomas), and female CD–1 mice (liver adenomas) in a statistically significant manner. A major metabolite, formaldehyde, is both a mutagen and potent probable human carcinogen. Another major metabolite, TBA, has been found to cause the formation of kidney tumors in male rats. All of these facts contribute convincingly to an overall weight of evidence for MTBE carcinogenicity. In fact, there appear to be no overall negative bioassay studies in animals at this time for MTBE and there have been no human epidemiological studies completed. In addition, the NCDEHNR Science Advisory Board on Toxic Air Pollutants has corroborated the BES identification of MTBE as an animal carcinogen by their statement that these studies represent "some evidence" of carcinogenicity of MTBE in animals (Science Advisory Board on Toxic Air Pollutants, 1994).

Based on the overall weight of evidence for MTBE carcinogenicity, the EES would classify MTBE as a B2 probable human carcinogen. This classification also indicates that the EES will review the North Carolina groundwater standard to reflect the

carcinogenicity of MTBE and should undertake a consideration of this compound's carcinogenic potential from an ambient air exposure standpoint. These steps are necessary to ensure human health protection from the extensive use and increased exposure of the public to MTBE.

The State of North Carolina's conclusion that MTBE should be classified as a B2 probable human carcinogen is consistent with my findings and conclusions.

H. U.S. EPA'S Cancer Potency of MTBE Analysis

While it is extremely prudent to use the total weight of the evidence (which is the generally scientifically accepted methodology) to classify MTBE as probable human carcinogen, as in the case of North Carolina, the drinking water exposure levels should not exceed that of benzene which is 5 ppb.

In February 1996, the U.S. EPA conducted an Interagency Assessment of Potential Health Risk Associated with Oxygenated Gasoline, which was concerned mainly with MTBE. Table 5 of the U.S. EPA's Interagency report describes the cancer potency estimates for MTBE based on tumor data from studies in rats and mice.

Using the EPA's potency data from Table 5, I have calculated the exposure level for MTBE. Although this is a acceptable method for calculating levels of exposure it is a less desirable method than others. In rats, based on the lymphomas and leukemia data from EPA's Table 5, the upper bound unit cancer risk is 4 x 10–3 mg/kg/day. This means that at this level of exposure to MTBE, one individual per 1000 individuals may develop cancer.

Title 15A, Section 2L-Groundwater Classification of North Carolina Standards General Statutes, Section .0102 Definitions (24) "Suitable for Drinking" defines "suitable for drinking" to mean "a quality of water which does not contain substances in concentrations which either singularly or in combination if ingested into human body, may cause death, disease, behavioral abnormalities, congenital defects, genetic mutations, or result in an incremental lifetime cancer risk in excess of 1 x 10 6 or render the water unacceptable due to aesthetic qualities including task, odor, or appearance." Thus, based on risk of cancer of 1 x $10-6$, the oral potency in rat for leukemia and lymphoma is 4 x $10-3$ cancer risk per mg/kg/day. Accordingly, a 4 x $1-6$ cancer risk per µg/kg/day for a 70 kg person would limit the exposure to 17.5 µg/L per day for a normal healthy individual.

CONCLUSION

The substantial weight of evidence clearly indicates that MTBE is carcinogenic. This is supported by several studies where MTBE was shown to cause cancers in two different species of experimental animals. In addition, the cancers caused by MTBE are identical to those caused by-exposures at the same doses as benzene, vinyl chloride, and 1,3-butadiene, which are known human carcinogens. Pregnant women, young children, and sensitive individuals are at an even greater risk of developing cancers.

It is an accepted scientific principle that when a chemical is shown to cause cancers in different species of experimental animals, it is considered a probable human carcinogen. Not only has MTBE been shown to be carcinogenic, the Biles et al. 1987 study indicates that it is also teratonenic. [11]

The permissible exposure levels of contaminants in drinking water for possible or probable human carcinogens are set extremely low, sometimes even as low as that for a known human carcinogen. Accordingly, I am of the opinion that in order to reduce or prevent unnecessary risks of individuals developing cancers, the drinking water standards should not exceed 5 ppb.

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA,
Office of the Board of Directors, December 9, 1997.

THE HONORABLE BARBARA BOXER,
Washington, DC 29510.

SUBMITTAL OF TESTIMONY ON MTBE CONTAMINATION

DEAR SENATOR BOXER: Thank you for holding this important hearing and for the opportunity to provide testimony and comment to the Senate Committee on Environment and Public Works. The forum that this hearing provides will go a long way toward focusing attention on the MTBE contamination at the Federal level.

[11] Pertaining to the production of physical defects in offspring in utero.

As the City of Santa Monica's representative to the Metropolitan Water District of Southern California's (Metropolitan) Board of Directors, I represent water utility that has suffered the most severe impacts of MTBE contamination. Metropolitan's board has supported State legislation this past year on MTBE contamination. With the passage of this legislation, it is my hope that focus can now shift to those areas of Federal regulation that govern interstate pipelines and research funding for clean-up of MTBE contamination.

I would have joined you in this morning's hearing, except that Metropolitan's Board of Directors, today, is expected to provide legislative direction to the staff regarding the issue. As a result of this direction, we will provide your committee with written comments for your consideration. I anticipate comments to be delivered to you within the next few days. Please do not hesitate to contact me for any additional information as you feel necessary.

Sincerely,

JUDY ABDO, *Member,*
Board of Directors.

STATEMENT OF METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

The Metropolitan Water District of Southern California (Metropolitan) appreciates the opportunity to provide testimony and comments to this hearing of the Senate Committee on Environment and Public Works on the issue of methyl tertiary butyl ether (MTBE) and its impacts on California's water supply.

Metropolitan through its 27 member agencies anal almost 200 public waler systems, provide nearly 600 percent of the drinking, water to over 16 million persons in six counties in Southern California. Metropolitan imports water from two sources: the Colorado River and the Sacramento-San Joaquin Delta. While most communities regard Metropolitan water as supplemental to local supplies, a few areas depend on Metropolitan to provide all of their water needs.

The use of MTBE as a gasoline additive has resulted in MTBE occurrence in surface and groundwater sources throughout California. When MTBE enters the water environmental, it poses special problems because of its unique properties that differentiate it from non-oxygenated gasoline. MTBE is not readily adsorbed by soil particles and is relatively low in volatility which makes it resistant to removal by natural or manmade treatment processes. Once in groundwater, it can move at virtually the same velocity as the water.

MTBE in drinking water is known to create unacceptable taste and odor at very low levels. Ingestion of water contaminated by relatively low levels of MTBE is believed to pose some health risk, but the degree and nature of the health risk is not yet certain. Both the United States Environmental Protection Agency (USEPA) and the State of California, Office of Environmental Health Hazard Assessment are currently reevaluating the health risk. The USEPA has also moved to include MTBE on its Drinking Water Contaminant Candidate List for possible regulation.

The City of Santa Monica, a Metropolitan member agency, has suffered the nation's most severe groundwater contamination to date. Vital groundwater aquifers continue to be vulnerable to leaking underground storage tanks and petroleum pipelines. Surface water reservoirs subjected to recreational motorcraft are showing persistent levels of MTBE contamination. A recent survey of surface water reservoirs and waterways open to recreational activity, indicate low levels of MTBE contamination. This survey involved reservoirs found around the State including several in Metropolitan's service area (Attached is the survey results from California's State Water Projects Lake Perris in Southern California).

MTBE use and its subsequent occurrence in drinking water has been the subject of extensive legislation in California. Four significant pieces of legislation dealing with MTBE and leaking underground storage tanks passed the State legislature and was signed by Governor Pete Wilson. The legislative package will provide water utilities and regulatory agencies with important tools to protect groundwater supplies. However, additional measures are still needed. Certain mandates in the recently passed legislation will accelerate treatment and remediation needs. The unique properties of MTBE will not make it amenable to conventional treatment removal.

While the debate continues over the use of MTBE as fuel oxygenate, Metropolitan recognizes the benefits of so-called cleaner burning fuels in reducing air emissions. However, we feel that there should be no environmental tradeoffs between the need for clear air and clean water. Metropolitan maintains that no matter which oxygenate is mandated by the State of California, it must be used and regulated in a manner that does net pose a threat to drinking water supplies.

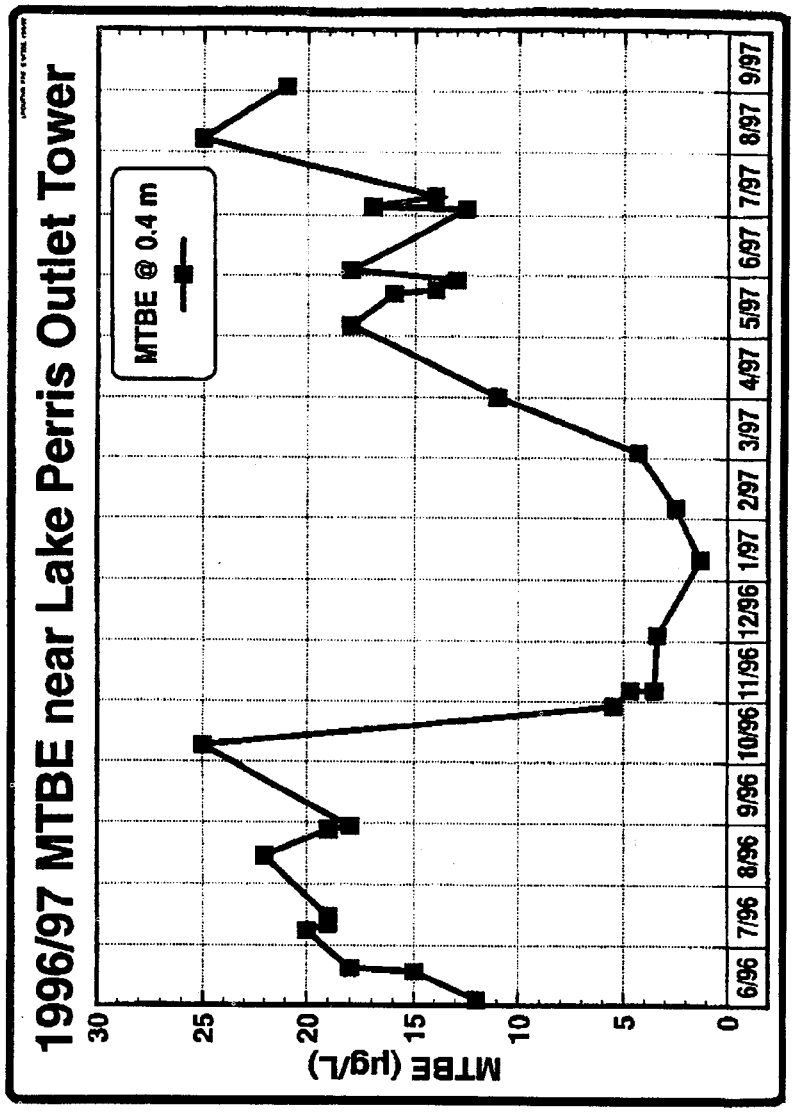
Metropolitan continues to support all efforts to deal with the problem of MTBE contamination of drinking water supplies. While legislative and regulatory efforts in the State of California have been significant, the following are areas that the Federal Government can be of assistance:

Pipelines. Interstate pipelines present a significant risk to drinking water sources. Current laws make them exempt from California State regulation. Interstate pipelines need improved monitoring and enforcement standards.

Funding. To address the needs of water utilities to treat and remediate MTBE contamination, research funding is badly needed for clean-up technologies.

Perchlorate. The new and equally difficult chemical contaminant of ammonium perchlorate has impacted water systems throughout the western United States. Perchlorate has entered the Colorado River watershed upstream of Parker Dam. Metropolitan is seeking Federal assistance in securing $100 million for contaminated groundwater interception and remediation technology as well as $10 million per year to cover the cost of "blending" Colorado River water to reduce perchlorate levels.

Metropolitan is pleased to hate the opportunity lo share flus comments and concerns on the use of MTBE and its impacts. Metropolitan is also ready to continue to work with all Federal agencies to address this serious contamination issue.



STATEMENT OF RICK HYDRICK, MANAGER OF WATER OPERATIONS, SACRAMENTO, CALIFORNIA

MTBE contamination is problem of national magnitude. Unfortunately, there hasn't been a national effort to address the problem. In fact, the response has been quite the opposite. South Tahoe Public Utility District, like many other small water suppliers, have found ourselves shouldering the weight of our contamination problem completely on our own.

No agency or water supplier in this country was prepared for the magnitude of MTBE contamination. The issue is how quickly we can gear up to respond to the threat. I can only speak to the South Tahoe experience, and our experience is that:

- regulatory agencies have not fully recognized the problem, therefore
- the agencies have not made MTBE contamination a priority, therefore
- there is no strategy to address the problem.

South Tahoe has been forced to essentially "go it alone" in trying to find solutions to our contamination problems. We first discovered MTBE in 1996. We immediately sought—and are still seeking—assistance at the regional, State and Federal levels. I can honestly report that not one agency said "Yes, we agree that MTBE in South Tahoe's drinking water is a problem that deserves the utmost attention." We have dogged out regional agency to help us aggressively address the threat MTBE poses to our water supply.

Regulatory agencies need to level with the public on this. We need to openly admit that we don't have most of the answers. We need to find out why, even when leaking underground tanks are replaced, we still have MTBE escapes from the site. But in a situation of this magnitude, we can't wait for all the studies, all the research—we must take a precautionary approach. We need to:

- find the potential sources of contamination
- eliminate those sources, quickly
- and treat the groundwater that is contaminated.

South Tahoe Public Utility District cannot do it alone, nor should we. We have spent $200,000 just dealing with MTBE in the past 7 months with absolutely no end in sight. We need Federal, State or regional assistance, immediately. We are not picky about who is going to step up to the plate, as long as somebody does.

We are sincerely appreciative of the effort that went into organizing this hearing, and we commend Senator Boxer for her diligence in pursuing solutions.

U.S. ENVIRONMENTAL PROTECTION AGENCY

DECEMBER 1997, OFFICE OF WATER, EPA 822-F–97–009

EPA FACT SHEET

DRINKING WATER ADVISORY: CONSUMER ACCEPTABILITY

ADVICE AND HEALTH EFFECTS ANALYSIS ON METHYL TERTIARY-BUTYL ETHER (MTBE)

The Advisory

The U.S. Environmental Protection Agency (EPA) Office of Water is issuing an Advisory on methyl tertiary-butyl ether (MTBE) in drinking water. This Advisory provides guidance to communities exposed to drinking water contaminated with MTBE. This document supersedes any previous drafts of drinking water health advisories for this chemical.

What is an Advisory?

The U.S. EPA Health Advisory Program was initiated to provide information and guidance to individuals or agencies concerned with potential risk from drinking water contaminants for which no national regulations currently exist. Advisories are not mandatory standards for action. Advisories are used only for guidance and are not legally enforceable. They are subject to revision as new information becomes available. EPA's Health Advisory program is recognized in the Safe Drinking Water Act Amendments of 1996, which state in section 102(b)(1)(F):

The Administrator may publish health advisories (which are not regulations) or take other appropriate actions for contaminants not subject to any national primary drinking water regulation".

As its title indicates, this Advisory includes consumer acceptability advice as "appropriate" under this statutory provision, as well as a health effects analysis.

What is MTBE?

MTBE is a volatile, organic chemical. Since the late 1970's, MTBE has been used as an octane enhancer in gasoline. Because it promotes more complete burning of gasoline, thereby reducing carbon monoxide and ozone levels, it is commonly used as a gasoline additive in localities which do not meet the National Ambient Air Quality Standards.

In the Clean Air Act of 1990 (Act), Congress mandated the use of reformulated gasoline (RFG) in areas of the country with the worst ozone or smog problems. RFG must meet certain technical specifications set forth in the Act, including a specific oxygen content. Ethanol and MTBE are the primary oxygenates used to meet the oxygen content requirement. MTBE is used in about 84 percent of RFG supplies.

Currently, 32 areas in a total of 18 States are participating in the RFG program, and RFG accounts for about 30 percent of gasoline nationwide.

Studies identify significant air quality and public health benefits that directly result from the use of fuels oxygenated with MTBE, ethanol or other chemicals. The refiners' 1995/96 fuel data submitted to EPA indicate that the national emissions benefits exceeded those required. The 1996 Air Quality Trends Report shows that toxic air pollutants declined significantly between 1994 and 1995. Early analysis indicates this progress may be attributable to the use of RFG. Starting in the year 2000, required emission reductions are substantially greater, at about 27 percent for volatile organic compounds, 22 percent for toxic air pollutants, and 7 percent for nitrogen oxides.

Why Is MTBE a Drinking Water Concern?

A limited number of instances of significant contamination of drinking water with MTBE have occurred due to leaks from underground and above ground petroleum storage tank systems and pipelines. Due to its small molecular size and solubility in water, MTBE moves rapidly into groundwater, faster than do other constituents of gasoline. Public and private wells have been contaminated in this manner. Nonpoint sources, such as recreational watercraft, are most likely to be the cause of small amounts of contamination in a large number of shallow aquifers and surface waters. Air deposition through precipitation of industrial or vehicular emissions may also contribute to surface water contamination. The extent of any potential for buildup in the environment from such deposition is uncertain.

Is MTBE in Drinking Water Harmful?

Based on the limited sampling data currently available, most concentrations at which MTBE has been found in drinking water sources are unlikely to cause adverse health effects. However, EPA is continuing to evaluate the available information and is doing additional research to seek more definitive estimates of potential risks to humans from drinking water.

There are no data on the effects on humans of drinking MTBE-contaminated water. In laboratory tests on animals, cancer and noncancer effects occur at high levels of exposure. These tests were conducted by inhalation exposure or by introducing the chemical in oil directly to the stomach. The tests support a concern for potential human hazard. Because the animals were not exposed through drinking water, there are significant uncertainties about the degree of risk associated with human exposure to low concentrations typically found in drinking water.

How Can People be Protected?

MTBE has a very unpleasant taste and odor, and these properties can make contaminated drinking water unacceptable to the public. This Advisory recommends control levels for taste and odor acceptability that will also protect against potential health effects.

Studies have been conducted on the concentrations of MTBE in drinking water at which individuals can detect the odor or taste of the chemical. Humans vary widely in the concentrations they are able to detect. Some who are sensitive can detect very low concentrations, others do not taste or smell the chemical even at much higher concentrations. Moreover, the presence or absence of other natural or water treatment chemicals can mask or reveal the taste or odor effects.

Studies to date have not been extensive enough to completely describe the extent of this variability, or to establish a population threshold of response. Nevertheless, we conclude from the available studies that keeping concentrations in the range of 20 to 40 micrograms per liter (ug/L) of water or below will likely avert unpleasant taste and odor effects, recognizing that some people may detect the chemical below this.

Concentrations in the range of 20 to 40 θg/L are about 20,000 to 100,000) (or more) times lower than the range of exposure levels in which cancer or noncancer effects were observed in rodent tests. This margin of exposure is in the range of margins of exposure typically provided to protect against cancer effects by the National Primary Drinking Water Standards under the Federal Safe Drinking Water Act. This margin is greater than such standards typically provided to protect against noncancer effects. Thus, protection of the water source from unpleasant taste and odor as recommended will also protect consumers from potential health effects.

EPA also notes that occurrences of ground water contamination observed at or above this 20–40, θg/l taste and odor threshold—that is, contamination at levels which may create consumer acceptability problems for water suppliers—have to date resulted from leaks in petroleum storage tanks or pipelines, not from other sources.

What is Being Done About the Problem?

Research. The EPA, other Federal and State agencies, and private entities are conducting research and developing a strategy for future research on all health and environmental issues associated with the use of oxygenates. To address the research needs associated with oxygenates in water, a public, scientific workshop to review the EPA's Research Strategy for Oxygenates in Water document was held on October 7, 1997.

Discussions included current, or soon to be started, oxygenate projects in the areas of environmental monitoring/occurrence, source characterization, transport and fate, exposure, toxicity, remediation, among others. The identified research will help provide the necessary information to better understand the health effects related to MTBE and other oxygenates in water, to further our knowledge on remediation techniques, and to direct future research planning toward the areas of highest priority. This document is expected to be available for external review by January, 1998. EPA plans to hold a workshop with industry to secure commitments on conducting the needed research in the Spring of 1998.

The EPA has also recently notified a consortium of fuel and fuel additive manufacturers of further air-related research requirements of industry under section 211(b) of the Clean Air Act (CM). The proposed animal inhalation research focuses on the short and long term inhalation effects of conventional gasoline and MTBE gasoline in the areas of neurotoxicity, immunotoxicity, reproductive and developmental toxicity, and carcinogenicity. The testing requirements will also include an extensive array of human exposure research. This research will be completed at varying intervals over the next 5 years and could be very useful for assessing risks from MTBE in water, depending on the outcome of studies underway on the extrapolation of inhalation risks to oral ingestion.

When adequate research on the human health effects associated with ingestion of oxygenates becomes available, the EPA Office of Water will issue a final health advisory to replace the present advisory.

Monitoring

The EPA's Office of Water has also entered into a cooperative agreement with the United States Geological Survey (USGS) to conduct an assessment of the occurrence and distribution of MTBE in the 12 mid-Atlantic and Northeastern States. Like California, these States have used MTBE extensively in the RFG and Oxygenated Fuels programs. This study will supplement the data gathered in California and will attempt to shed light on the important issues of (1) whether or not MTBE has entered drinking water distribution systems or impacted drinking water source supplies, and (2) determine if point (land) or nonpoint sources (air) are associated with detections of MTBE in ground water resources. Activities are underway to begin collecting data in early 1998.

Underground Storage Tanks

Under EPA regulations, leaks from underground storage tank systems (USTs) which may cause contamination of groundwater with MTBE or other materials are required to be reported to the implementing agency, which, in most cases, is a State agency. The EPA Office of Underground Storage Tanks and State and local authorities are addressing the cleanup of water contaminated by such leaks. All USTs installed after December 1988 have been required to meet EPA regulations for preventing leaks and spills. All USTs that were installed prior to December 1988 must be upgraded, replaced, or dosed to meet these requirements by December 1998.

Safe Drinking Water Act Candidate List

The Safe Drinking Water Act (SDWA), as amended in 1996, requires EPA to publish a list of contaminants that may require regulation, based on their known or anticipated occurrence in public drinking water systems. The SDWA, as amended, specifically directs EPA to publish the first list of contaminants (Contaminant Candidate List, or CCL) by February 1998, after consultation with the scientific community, including EPA's Science Advisory Board, and after notice and opportunity for public comment. The amendments also require EPA to select at least five contaminants from the final CCL and make a determination of whether or not to develop regulations, including drinking water standards, for them by 2001. The EPA Office Water published a draft CCL for public comment in the Federal Register on October 6, 1997 (62 FR 52194). MTBE is included on the draft CCL based on actual MTBE contamination of certain drinking water supplies, e.g., Santa Monica, and the potential for contamination of other drinking water supplies in areas of the country where MTBE is used in high levels.

How Can I Get My Water Tested?

A list of local laboratories that can test your water for MTBE can be obtained from your State drinking water agency. The cost for testing is approximately $150 per sample. The analysis should be performed by a laboratory certified to perform EPA certified methods. The laboratory should follow EPA Method 524.2 (gas chromatography/mass spectromety).

How Can I Get Rid of MTBE If It's In My Water?

In most cases it is difficult and expensive for individual home owners to treat their own water. Any detection of MTBE should be reported to your local water authority, who can work with you to have your water tested and treated.

Are There Any Recommendations for State or Public Water Suppliers?

Public water systems that conduct routine monitoring for volatile organic chemicals can test for MTBE at little additional cost, and some States are already moving in this direction.

Public water systems detecting MTBE in their source water at problematic concentrations can remove MTBE from water using the same conventional treatment techniques that are used to clean up other contaminants originating from gasoline releases, such as air stripping and granular activated carbon (GAC). However, because MTBE is more soluble in water and more resistant to biodegradation than other chemical constituents in gasoline, air stripping and GAC treatment requires additional optimization and must often be used together to remove MTBE effectively from water. The costs of removing MTBE will be higher than when treating for gasoline releases that do not contain MTBE. Oxidization of MTBE using UV/peroxide/ozone treatment may also be feasible, but typically has higher capital and operating costs than air stripping and GAC.

To Obtain the Advisory: Call the National Center for Environmental Publications and Information (NCEPI) at 1800–490–9198 to be sent a copy or write to NCEPI, EPA Publications Clearinghouse, P.O. Box 42419, Cincinnati, OH 45242 .

Internet download: www.epa.gov/OST/Tools/MTBEaa.pdf

To Obtain the Research Strategy on Oxygenates in Water, External Review Draft, Contact: Diane Ray, U.S. EPA, Office of Research and Development, NCEA, MD–52, RTP, NC 27711 or by phone (919) 541–3637.

Internet download: www.epa.gov/ncea/oxywater.htm

To Obtain the 211(b) Air-Related Research Requirements, Contact: John Brophy, U.S. EPA, Office of Air and Radiation; phone (202) 564–9068; www.epa.gov/omswww/omsfuels.htm

For Further Information on the Advisory, Contact: Barbara Corcoran, U.S. EPA, Office of Water, Mail Code 4304, 401 M St. S.W., Washington, DC. 20460, or by e-mail at MTBE.advisory

epamail.epa.gov, or by phone at (202) 260–5389.

For Further Information on the Research Strategy, Contact: Diane Ray, U.S. EPA, Office of Research and Development, NCEA, MD–52, RTP, NC 27711 or by phone (919) 541–3637.

MEMORANDUM

OFFICE OF WATER, U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

December 8, 1997

SUBJECT: Issuance of the Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Methy Tertiary-Butyl Ether (MTBE)

FROM: Tudor T. Davies, Director, Office of Science and Technology (4301)

TO: Addressees

The Office of Water's Office of Science and Technology is transmitting the December 1997 Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Methyl Tertiary Butyl Ether (MTBE). The Office of Water (OW) Health Advisory Program was initiated to provide information and guidance to individuals or agencies concerned with potential risk from drinking water contaminants for which no national regulations currently exist. Advisories are used only for guidance and are not legally enforceable. The purpose of this Drinking Water Advisory is to support immediate needs for information by State and local drinking water facilities and public health personnel due to MTBE contamination of potable water. The scope of this Advisory is limited to an examination of cancer and non-cancer data, as well as organoleptic (taste and odor) effects which may affect consumer acceptance of the water supply, and does not include information on other subjects

typically found in an health advisory, such as treatment technology and analytical methods. This Advisory does not recommend either a low-dose oral cancer risk number or a reference dose (RfD), due to certain limitations of available data for quantifying risk.

MTBE is a widely used octane enhancer that promotes more complete burning of gasoline and reduces carbon monoxide (CO) levels in air. The most common source of ground water contamination by MTBE is leakage from underground storage tanks. Drinking water contamination is most likely a consequence of MTBE's small molecular size and relatively high water solubility, which permits it to readily migrate through water sources. Non-point sources, such as recreational watercraft, are most likely to be the cause of small amounts of contamination of surface waters. Air deposition through precipitation of industrial or vehicular emissions may also contribute to surface and ground water contamination.

Since the Office of Water does not believe there is an adequate data base for developing a Lifetime Health Advisory value for MTBE, it is making a policy call and issuing this Advisory to provide an evaluation of current health hazard information and to discuss how far various environmental concentrations are from concentrations at which toxic effects have been seen in test animals. (This comparison is called a "margin of exposure" or MoE; for instance, if a measured concentration is 100,000 times less than the range of minimally adverse effects noted in test animals, the MoE is 100,000.)

Were are many uncertainties and limitations associated with the toxicity data base for this chemical. The animal tests available to date were not conducted by exposing the animals to MTBE in drinking water, but rather by inhalation or introduction of the chemical in oil directly to the stomach several times a week. Although useful for identifying potential hazards, limitations of the reported studies do not allow confident estimates of the degree of risk MTBE may pose to humans from low level drinking water contamination. The toxicokinetic models are also limited for extrapolating results from inhalation studies to effects from oral exposure to drinking water sources. Ongoing research is needed to resolve these issues before a more complete health advisory can be developed. Nevertheless, the available data allow a conclusion that keeping MTBE concentrations in the range of 20 to 40 micrograms per liter of water or below to protect consumer acceptance of the water resource would also provide a large margin of exposure from the toxic effects. Taste and odor values are presented as a range, since human responses vary depending on the particular individual and the site-specific water quality conditions. These levels are about 20,000 to 100,000, or more, times lower than the range of exposure levels in which cancer or noncancer effects were observed in rodent tests. This margin is in the range of margins of exposure typically provided for cancer effects by National Primary Drinking Water Standards under the Federal Safe Drinking Water Act.

When the data base is improved enough to allow greater confidence in the toxicity conclusions, the Office of Water will publish another Advisory for MTBE that includes quantitative estimates for health risks. This Advisory is not a mandatory standard for action, but provides practical guidelines for addressing contamination problems and supersedes previously published draft advisories.

If you have any questions regarding this Advisory, contact Barbara Corcoran, the OST Health Advisory Program Manager (mail code 4304; telephone 202–260–1332).

OXYBUSTERS,
Lodi, CA, December 9, 1997.

HONORABLE SENATOR BARBARA BOXER
Senate Environment and Public Works Committee
Washington, DC 20510

My name is Jodi Waters and I am the founder of California OxyBusters. We are a true grass roots organization in the sense that all of our support and financing has come from individual citizens and a few small businesses. Our primary purpose is to stop the use of MTBE in our gasoline and our secondary goal is to stop the use of all oxygenates in gasoline because we are convinced that all of them do more harm than good. This is especially true of MTBE.

I became concerned about MTBE while I was caring for the health problems of a neighbor over a period of a year or so. Her doctors could not figure out what was wrong or how to treat her. One day I heard about Dr. Peter Joseph on the radio and the health effects of MTBE and realized that his information on MTBE described my neighbor's problems exactly and, since we live about a block from a busy freeway, that it logically fit. Her symptoms went away when she left the State of California to an area where they don't use MTBE.

More research quickly convinced me that MTBE was a bad poison. So I started California OxyBusters in December of 1996 to try to get it out of our gasoline. Since then I have been contacted by over 60000 concerned and angry Californians by mail, phone, fax and personal discussion at many public events. This figure is separate from the over 110,000 people who signed our petition to ban MTBE in California although I am sure that most of those 60,000 people also signed the petition.

The health effects of MTBE to humans are well documented by others testifying here today, but for completeness I wish to enter into the record the two booklets that OxyBusters printed that were authored by Dr. Peter Joseph.

As far as MTBE's effects in water, there are several points that should be made and I will be happy to supply lots of documentation in support of these points to you or anyone else who wants it.

Unlike gasoline, MTBE is soluble in water. This means that when a spill or leak of MTBE or gasoline containing MTBE occurs that the MTBE dissolves in whatever surface or ground water may be present, separating from the gasoline. The MTBE then migrates with the water to wherever that water goes. This means that it can spread rapidly and move a long distance. MTBE is not broken down by natural microorganism, as is spilled gasoline without MTBE, so it lasts many years in the aquifer. MTBE is also very difficult and expensive to remove to the point of being economically infeasible. This means that once it is in a community water supply those people have problems. Big problems.

An example of just such an occurrence is the small mountain community of Glennville, CA about 35 miles east of Bakersfield. Glenoville's water supply is contaminated by MTBE in concentrations of up to 320,000 parts per billion following a gasoline spill in 1986. (35 parts per billion is the standard set by the California EPA, and the doctors and scientists say that 0–5 parts per billion is the mad acceptable level.) After the spill, Kern County received money from the Environmental Superfund to clean-up the spill, but instead turned the funds over to the State of California. The State, however, failed to either cleanup the spill or warn the residents of Glennville of the hazard. Consequently the residents suffered for years with a wide range of unexplained ailments and severe allergic reactions, now known to have been caused by MTBE. Now they have been told not drink or bathe in the water because it will make them sick. The State said they would providing drinking water, but it took them 4 months after informing them of the danger to even do that. The State is not providing bathing water nor are they going to clean up the spill. These people are trapped—they can't sell their property, they can't rent, and they can't use it themselves. They can't bathe, wash clothes or drink their own water. They are powerless against what has happened. The State is in control. These people need help and they are just being hung out to dry by the State and the oil companies that poisoned their water. California OxyBusters is the only group that has come to their aid.

Here is a bottle of water from Glennville's water well. Just smell it—taste it if you dare. And many bureaucrats and oil company of ficials still say this stuff isn't a problem! They say they can contain it. Really? MTBE eats through the new double lined fiberglass fuel tanks and it is calculated that it will take 1,000 years to recycle safely through the environment. IT ISN'T A PROBLEM?! For whom? The bureaucrats or the people who have to breath, drink and bathe in it? The EPA was created to solve problems like this, not create them.

MTBE recycles in the environment. It evaporates from surface spills and fumes escape into the atmosphere during pumping. Incomplete combustion also emits small amounts of MTBE into the atmosphere. All this airborne MTBE then dissolves into the airborne moisture and eventually falls all over the earth in the form of MTBE rain. Remember ACID rain? Well, now we have MTBE rain! The concentrations are obviously far less than from direct spills, but since it does not readily biodegrade, the effect is cumulative and someday in the future MTBE contamination will be a problem for virtually everybody on the planet.

Realize too that this is the same water that is used to grow all of our food supplies. All flora and fauna depend on rain water, directly or indirectly, for life. This includes you and me, Senator. What happens when all water contains MTBE? What will happen is that all of our food will contain MTBE. The food that you and I and our children eat.

The EPA is supposedly about saving the earth for our children and future generations. How does MTBE play into this picture? Who is making big money off this product and what do they want us to believe? It takes a village to make sure that bureaucrats really do act in the best interest of the children, because we, the "villagers," know that MTBE is clearly NOT in the best interest of the children.

So I ask you—who is safe from MTBE? Are you? Are you drinking it now, today, here in this building? Consider the fact that it is in every waterway in California

(as stated by Deputy Director Hart of the State Water Resources Board). The people of California have fought many political civil wars over water issues. And now the State and big business are poisoning that water. There is nothing more important to the people of California than their cars or their water. Which is going to be taken away from them first? Is MTBE in our best interest, the best interest of our children, or in the interest of power, money and control? I think you know my opinion.

Thank you,

JODI M WATERS,
President, California OxyBusters

REFORMULATED GASOLINE: A SOURCE OF ILLNESS?

AN OPEN LETTER TO PHYSICIANS

PETER M. JOSEPH, PH.D., PROFESSOR OF RADIOLOGIC PHYSICS IN RADIOLOGY, HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA

I believe there is a new illness in our region which is affecting thousands of people and is largely unknown and unrecognized by most patients and physicians.[1] It is due to a sensitivity reaction to a chemical used in the new "reformulated" gasoline (RFG) whose sole purpose is, ironically, to improve our health. The chemical is methyl tertiary butyl ether (MTBE). Whether adding such oxygenated chemicals to gasoline really reduces vehicle emissions is now considered by many to be doubtful, consistent with earlier analyses.[2]

The symptoms can be roughly categorized as respiratory, neurological, or allergic.

The respiratory symptoms include inflammation of any of the mucous membranes in the upper respiratory track (URT), including sinusitis, rhinitis, pharyngitis, or bronchitis. These symptoms are almost indistinguishable from those of common viral URT infections. However there is rarely any fever, and any discharge can be categorized as more typical of allergic reactions than of infection. More important, the time course is very different from URT infections, since the symptoms continue for an indefinite period of time, usually many weeks or months, but are often modulated by subtle changes in the weather conditions (see below). Patients report a feeling of severe malaise, described as "I just feel terrible." Antihistamines are usually not helpful, certainly not as much as they are in conventional seasonal allergies.

Perhaps the most important respiratory effect is exacerbation of asthma, the prevalence of which is apparently skyrocketing in the Philadelphia and New Jersey area. The Philadelphia Department of Health has formed a special Asthma Task Force to try to understand and cope with this problem.

The neurological symptoms include headache, nausea, insomnia, and sometimes visual disturbances. One symptom I have found most troubling is a sense of lightheadedness, similar to ethanol intoxication. Some patients complain of lethargy. These can be modulated by weather conditions or be constant for many weeks. A special case of neurologic symptoms is cardiac arrhythmia experienced by a very small percentage of sensitive people.

The allergic symptoms commonly are skin rash or tearing in the eyes. These are exacerbated by exposure to gasoline fumes or byproducts, such as by riding in cars in heavy traffic.

Some people, including myself, experience a hot flushed feeling in the skin of the head and neck.

Very few people get all of these symptoms, more commonly only a few are seen. It is relatively common for one person to have either the respiratory or neurological symptoms, but not both.

Some of these symptoms would normally be attributable to more conventional causes, such as emotional stress or viral infections. To make it clear why I am convinced that they are caused by the gasoline additive MTBE, I must describe some history.

When MTBE was added to gasoline in Fairbanks, Alaska, in the winter of 1992, many people (estimated to be 10 percent of the population) complained of the above symptoms. The symptoms were associated with gasoline fumes and/or exhaust in that they got worse when people drove in traffic and better in their homes out of town. The CDC did a thorough investigation, including measuring blood levels of

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[1] Joseph P.M., Letter: Atmospheric Byproducts of MTBE as a Source of Community-wide Illness. Arch. Env. Health 1995;50:395–396.

[2] Calveri J.G., Heywood J.B., Sawyer R.F., Seinfeld J.H., Achieving acceptable air quality: Some reflections on controlling vehicle emissions. Science 1993;261 :37–45.

MTBE and its metabolite TBA.[3] The Governor of Alaska demanded that MTBE be removed and the symptoms complaints promptly subsided. The same scenario was repeated at the same time in Missoula, Montana with the same result, except that the CDC was not involved. Since then, spontaneous citizen protest groups have arisen in Maine, Pennsylvania, New Jersey, Connecticut, Colorado, Texas, and Wisconsin. In New Jersey, the citizens' group "Oxybusters" has collected about 13,000 petition signatures against MTBE. In January, 1995, ABC Television ran a 15 minute documentary explaining the history of this problem.[4]

MTBE has been used as a gasoline additive since approximately 1979. However, it was used solely to increase the octane of some brands of premium gasoline and the total amount used was roughly an order of magnitude less than today. In our region, we were required to have 15 percent MTBE in all gasoline starting in the winter of 92–93, and again each winter since then. We are currently (since March 1, 1995) required to have 11 percent MTBE 12 months per year as part of the national RFG program.

My own history started also in the winter of 92–93. At that time my symptoms were mainly neurological, including intractable insomnia. I had several extensive diagnostic workups, and was diagnosed with multiple environmental allergies, including dust mites. After cleaning up my home environment, l noticed some improvement in the early spring. (Note that pollen allergies get worse in spring!) I did suffer pollen allergy symptoms throughout most of 1993, and started on immunotherapy shots in September 1993. I did not notice any severe problems in November 1993 when MTBE was again reintroduced. I did contract pneumonia in mid December which was treated with antibiotics. However, even after the pneumonia cleared I continued to feel sick, with the symptoms of malaise and lightheaded described above. I found that a light box designed to treat winter depression was not effective.

Around the end of January 1994, I noticed that many colleagues were not feeling well. Through casual conversation I found two men and two women who also had the lightheaded feeling. One woman also had a continuous headache for which her doctor's prescription of analgesics were not helpful. The symptoms of the three men not only varied from day to day, but almost always in synchrony! This certainly suggests some sort of environmental cause. We all got better on sunny days and worse on cloudy days. For example, Sunday February 20 started out as a bright, cold, winter day. l felt fine that morning and went walking in my suburban neighborhood. By afternoon, the skies clouded over, and by evening I felt very sick (malaise, nauseous) and slept poorly. The next day I discovered that the other two men had identical experiences. By comparison, March 10 (when oxygenated gasoline was no longer required) was also a cloudy day and we all felt fine. All symptoms of all five people disappeared by the middle of March, and we all remained well throughout the spring, summer, and fall of 1994. However, in November 1994 when MTBE was again put into gasoline, four of us again developed the same symptoms as before. l found that an air filtering machine which could absorb organic compounds including formaldehyde was very helpful in controlling my symptoms. This story was described in the February 19 issue of the Philadelphia Inquirer.

During the winter of 1994–95 my own symptoms in the URT became worse, with definite pain in the chest, cough, and several difficult URT infections. These symptoms, together with the malaise and lightheadedness described above, are always much worse on cloudy days when there is no rain or wind. Cloudy days with rain or wind are noticeably better, but not as good as sunny days. During March 1995 almost every evening, when the sun went down, l would feel ill .

In January and February 1995 I made several public appearances on radio and television asking for people with similar problems to contact me. l have spoken to over 100 people who believe their symptoms may be caused by MTBE. In some cases, the people had pre-existing medical conditions which could also explain their symptoms. However, in most cases it is my judgment that MTBE is the most likely cause. A few of those people have written letters giving their detailed history and in most cases it is very hard to find any other plausible explanation other than MTBE. In some cases, the symptoms recurred in synchrony with our regional MTBE usage, and in other cases the symptoms completely resolved when the people (temporarily) travelled to another geographic region which did not have the high levels

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[3] Moolenaar R.L., Hefflin B.J., Ashley D.L., Middaugh J.P., Etzel R.A. Methyl tertiary butyl ether in human blood after exposure to oxygenated fuel in Fairbanks, Alaska. Arch. Env. Health 1994;49:402–408.

[4] California OxyBusters was organized in December, 1996 and by May, 1997 had collected over 80,000 petition signatures in support of legislation to remove MTBE from gasoline. The bill, SB521, is going through the legislative process as of this date.

of MTBE. Personally, I am completely convinced that MTBE is capable of causing the illnesses reported.

We should ask how this situation could come about, and whether the government had not tested MTBE before requiring us to use it. The Environmental Protection Agency (EPA) is the primary advocate of the use of so-called "oxygenate" chemicals in gasoline, the goal being to reduce carbon monoxide emissions by more complete oxidation (so-called "cleaner burning"). The EPA imposed MTBE on Denver starting in the winter of 1988, and claims that no significant complaints were received. However, I personally know of several individuals in that area who were affected and who say that the EPA dismissed their complaints as being groundless. I have copies of written complaints by 65 people in Colorado Springs from the winter of 1992.

There have been several toxicologic studies of MTBE in rats and mice which indicated no permanent damage. However, there are short temm neurological effects such as would be expected from any ether. There have been a few short term acute exposure studies with human volunteers; these were all done with healthy young adults. The CDC did another driver survey study in Stamford Connecticut in March 1993 and found people reporting the same symptoms as in Fairbanks, Alaska[5]. They concluded that "Persons with high blood concentrations of MTBE reported a high prevalence of one or more of the key symptoms . . . that had been previously associated with MTBE exposure in Fairbanks, Alaska. This association appears to be specific to these symptoms." A study of New Jersey garage workers in 1993 compared northern and southern workers who had high and low MTBE exposure, respectively and claimed to find no difference. However, their group of northern workers who pump gasoline more than 5 hours per day did show a statistically significant (P=0.03) increase in MTBE symptoms. Some people interpret that study as negative because in a specially selected subgroup of only 11 individuals no increase in MTBE-type symptoms was found. That obviously does not rule out a possible sensitive subgroup on the order of a few percent. Meanwhile, since 1993, many more automobile and gasoline workers in New jersey have concluded that MTBE in gasoline is ruining their health. I have spoken to several of them.

I am convinced that the EPA has not properly understood the nature of this problem. When MTBE is dispersed in the atmosphere, it can be converted by atmospheric chemistry into tertiary butyl formate (TBF), which is an ester of formic acid. To date there are no studies of the effects of chronic exposure to TBF, but since it is an irritant it is a possible contributor to the respiratory effects of concerto Even more likely is the direct production of formic acid in the exhaust stream of cars burning MTBE; this is expected to result from the partial oxidation of MTBE into TBF, and the subsequent pyrolysis of TBF into fommic acid and isobutylene.[6] Another possible byproduct of MTBE combustion is tertiary butyl nitrite (TBN), which is known to be destroyed by sunlight. TBN is structurally analogous to amyl nitrite, a drug of abuse with known neural-vascular effects.

So far, the EPA has funded any biological or clinical studies of the effects from the TBF produced from MTBE, and there is virtually no information on it in the toxicologic literature. However, it is expected to be similar to other formates, such as formic acid (FA). FA is known to be extremely irritating to the mucous membranes of the respiratory system. In fact, it is more irritating than fommaldehyde, at least in guinea pigs.[7] It is also toxic to the nervous system and is the major toxin active in methanol poisoning. FA will accumulate in monkeys and humans but not in lower animals.[8] This might explain why experiments with rodents did not show any problems. It is not known how the metabolism of TBF compares with FA.

The only information on TBF itself I could locate is this description of the acute effects, taken from the manufacturers "MSDS" (material safety data sheet):

Acute Effects

- Harmful if swallowed, inhaled, or absorbed through the skin;
- Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin;
- Inhalation may be fatal as a result of spasm, inflammation and edema of the larynx and bronchi, chemical pneumonitis and pulmonary edema;

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[5] White M.C., Johnson C.A., Ashley D.L., Buchta T.M., Pelletier D.J. Exposure to Methyl Tertiary-Butyl Ether from Oxygenated Gasoline in Stamford, Connecticut. Arch. Env. Health 1995;50:183–189.

[6] Gordon E., Price S.J.W., Trotman-Dickerson A.F. The pyrolsis of tert. Butyl Formate. J. Chem. Soc. 1957;1957:2813–2815.

[7] Amdur M.O. The response of guinea pigs to inhalation of formaldehyde and formic acid alone and with a sodium chloride aerosol. Int. J. Air Pollut. 1960;3:201–220.

[8] Tephly T.R. The toxicity of methanol. Life Sci. 1991 ;48: 1031–1041.

- Symptoms of exposure may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea and vomiting;
- To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

In addition to the cloudy day effect, many individuals resort that their symptoms get worse at night. This might be due to an alternate chemical pathway for conversion of MTBE into TBF which uses nitrate radicals, rather than hydroxyl radicals, and is expected to function only at night.[9] However, I consider it more likely that some toxic compound is being produced directly from the exhaust of cars, and that for some reason this compound is either destroyed or dispersed by sunlight. One such compound, TBN, is known to be rapidly destroyed by sunlight. Another possibility is that FA accumulates in water droplets on cloudy, humid, days, and these are rapidly vaporized when the sun emerges. (It is known that acid irritants are more troublesome when condensed onto particles than when in the gaseous phase[10]) Various studies of FA in ambient air show huge day-to-day fluctuations.[11][12] Direct automotive production of FA would be maximal during the winter when the evening commuting rush hour occurs in darkness. All experimental studies of automobile exhaust that I have seen ignore the production of FA as well as most other possible products of the combustion of MTBE. However, it is known that hydroxyl radicals (OH) are present in the combustion process, and it is also known that such radicals can convert MTBE into TBF.[13] The published studies[14][15] look only for a preselected list of pure hydrocarbons, plus a handful of aldehydes. These studies invariably list a few percent "unidentified hydrocarbons." In some cases the quantity of "unidentified hydrocarbons" increased when MTBE was added to the fuel.[14] This is extremely important because proponents of MTBE talk as if it were proven that adding MTBE to gasoline can only decrease all possible exhaust products (except for fommaldehyde, acknowledged to be increased with MTBE). Furthermore, one would expect production of FA to be maximal during periods of acceleration when the car's air/fuel system tends to bum a mixture which has excessive fuel, thus greatly enhancing production of FA and other products of partial oxidation.

Many individuals have noticed a foul odor coming from cars burning MTBE–RFG under certain conditions, such as acceleration during cloudy days. From subjective experiments in my own garage, comparing exhaust from MTBE versus ethanol RFG, I can say that there is some extremely foul and irritating substance produced from MTBE fuel that is not found with ethanol fuel. Furthemmore, my symptoms did increase while breathing air in the environment with the MTBE-RFG.

It is known that the main metabolic products of MTBE are fommaldehyde (F) and tertiary butyl alcohol (TBA). F is known to be both toxic and a potent sensitizer. TBA is not as well known, but there is a report of allergy[16] which suggests that it also can sensitize.

Many Philadelphians would agree with the statement that the 1995 flu season was one of the worst they can remember. This impression has been publicly documented for New York City by the New York Times[17] on January 17, which said "The flu and cold season has singled out New York with particular fury this year. While much of the country has remained unusually healthy this winter, many New Yorkers have coughed, sneezed and wheezed their way into the new year," and on

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[9] Langer S., Ljungstroem E. Reaction of the nitrate radical with some potential automotive fuel additives. A kinetic and mechanistic study. J. Phys. Chem. 1994;98:5906–5912.

[10] Wilson R., Spengler I.D., Particles in our Air: Concentrations and [lealth Effects. (Harvard Univ. Press, Cambridge, MA, 1996), pp. 88–91.

[11] Grosjean D. Formic Acid and Acetic Acid Measurements during the Southern California Air Quality Study. Atmospheric Environment 1990;24A:2699–2702.

[12] Lawrence J.E, Koutrakis P. Measurement of Atmospheric Formic and Acetic Acids: Methods Evaluation and Results from Field Studies. Environ. Sci.Technol. 1994;28:957–964.

[13] Smith D.F., Kleindienst T.E., Hudgens E.E., McIver C.D., Bufalini J.J. The photooxidation of methyl tertiary butyl ether. Int. J. Chem. Kin. 1991;23:907924.

[14] Kirchstetter T.W., Singer B.C., Harley R.A., Kendall G.R., Chan W. Impact of Oxygenated Gasoline Use on California Light-Duty Vehicle Emissions. Environ. Sci. Technology 1996;30:661–670.

[15] Hoekman S.K. Speciated Measurements and Calculated Reactivities of Vehicle Exhaust Emissions from Conventional and Reformulated Gasolines. Environ. Sci. Technology 1992;26:1206–1216.

[16] Edwards, Jr, E.K., Edwards E.K. Allergic reactions to tertiary butyl alcohol in a sunscreen. Cutis. 1982;29:476–478.

[17] Rosenthal E. Flu casts fevered misery across New York region. (New York Times, New York, 1995), pp. 1–2.

February 2, "upstate New York, (was) not as badly hit by the flu epidemic".[18] One would normally attribute this to increased virulence of the virus causing the infections. However, the unusually severe symptoms were seen in a only few east coast cities, and not in upstate New York or Boston, for example. These other areas have not been exposed to MTBE in gasoline for nearly as long (three winters) as we have. I propose that the true explanation lies in the irritative effects of FA on the respiratory mucous membranes which, coupled with induced sensitization in some manner not fully understood, weakened our normal ability to resist the influenza virus.

The New York Times did not run any articles commenting on the seventy of the 1996 flu season, except that it arrived unusually early.[19] However, I do know of several individuals in Philadelphia who suffered with extremely resistant respiratory infections that required many weeks of antibiotic therapy before resolution.

It seems clear that only a small minority of people are continually affected by these new pollutants; I estimate the fraction to be a few percent. We are clearly dealing with a question of a subpopulation which is or has become sensitive to one or more of these chemicals. Since many more people are reporting these symptoms now than in the previous 2 years, we can conclude that more people are becoming sensitized through chronic exposure. There is no doubt in my mind that thousands of people are suffering from this without any suspicion of the true cause.

There is now preliminary evidence that some component of MTBE induced pollution is inducing cardiac arrhythmias in some susceptible people. These people report that their heart sometimes skip beats, and the problem disappears when they travel to areas not requiring oxygenated gasoline. One person reported that his heart immediately stabilized when he flew in an airplane. He has since moved from New York City because he could not tolerate the medical problems he was having that he attributed to the MTBE-related air quality. The observation that this problem gets worse at night suggests that FA or TON may be a factor. Also interesting is the fact that the 1993 Vital Statistics report from New York State indicates that, whereas the death rate from non-ischemic heart disease had been dropping steadily since 1988, beginning in 1992 it began to climb again in New York City. The fact that a much smaller rise was seen in "the rest of New York State" suggests some environmental factor present in New York City but not New York State. MTBE was mandated mostly in the New York City area and surrounding suburban counties, and not in most of upstate New York. A similar, but smaller, increase is seen in the Vital Statistics reports from Philadelphia in 1992, 1993, and 1994. Obviously, further research on this problem is needed.

The intensity of symptoms decreased for myself and many others in early April 1995. This is probably due to the reduced emission of FA from cars which are not being driven while very cold as in the winter. However, I and others I know with this sensitivity still usually feel worse on dark, cloudy days without rain. The fact that rain clears our symptoms argues against some effect attributable to reduced air pressure or lack of perceived sunlight. Furthermore, in the fall and winter of 1995–96 I and many others again experienced increasing difficulties, although generally not quite as bad as the winter of 1995. This relative improvement is probably due to the fact that Philadelphia was required to use only 11 percent MTBE in 1995–96, rather than the 15 percent of the previous winters. A similar reduction in intensity of symptoms was not reported by individuals in Fairfield County, Connecticut, where the gas was again required to contain 15 percent MTBE. The general worsening of symptoms in winter may also be due to the shortening of daylight hours, thus exposing us to more FA or TON.

The question of what the practicing physician can do is difficult. Since the very existence of the disease is controversial, there are no established treatment guidelines. Antihistamines are usually not helpful, with the possible exception of the skin rashes. In several cases of extreme skin rash, treatment with high doses of oral prednisone for several weeks was necessary. This is not surprising since sensitivity to small molecules may not be mediated by the IgE allergic responses that lead to excessive histamine release. l speculate that sensitivity to poison ivy may be a more chemically accurate analogy. However, in this case the agent is being inhaled rather than applied to the skin. Current medical opinion is divided on the nature of the neurological or immunological reactions in this type of sensitivity reaction.

Some people go on to develop major respiratory problems similar to, or possibly including, asthma, which require inhaled steroids for management. In some cases

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[18] Fein E.B. With blood shortage near crisis, hospitals prepare to delay operations. (New York Times, New York, 1995), pp. 3–3.

[19] Belluck P. Sneezing Season is Early and Hospitals Reflect It. (New York Times Dec. 6, New York, 1995), pp. 1–5.

the physicians diagnose only "dyspnea" since spirometry tests for asthma are negative. I believe that the increase in asthma rates in cities in recent years is largely attributable to the increased usage of MTBE in gasoline over this period of time. MTBE was first approved for use in gasoline in 1979, exactly the year that asthma mortality abruptly reversed direction; what had been a steady decline and has been climbing ever since.[20] [21] The Philadelphia Inquirer[22] said that asthma deaths in Philadelphia have tripled since 1981. Recent statistics from the Philadelphia Department of Health showed an increase of 44 percent in office visits for asthma from 1993 to 1995, exactly the period when MTBE and RFG have been required. Prevalence data obtained by a school nurse in Downingtown, PA show a 100 percent increase between October 1992 and October 1993, following the introduction of 15 percent MTBE in November 1992. No one has offered any other plausible explanation for this explosive growth in asthma other than FA. On September 5, 1995 the New York Times ran a front page article[23] describing rising asthma rates in the Bronx; the death rate of 11.0/100,000 is 26 times the national average in 1988! I have spoken to several school nurses (two in Delaware County, two in Chester County, and one in Nutley New Jersey) who were (independently) unanimous in their observation that they have seen a huge increase in childhood asthma over roughly the last two or 3 years. Some writers have suggested that the increase in childhood asthma is limited to the minority populations in the inner cities. My information does not support that idea. Downingtown, PA, for example is in Chester County, a semi-rural area about 40 miles west of Philadelphia. One man who coaches athletics in a very wealthy "Main Line" suburb of Philadelphia says he has seen a huge increase in asthma in children over "the last three or 4 years."

Further evidence that usage of MTBE in gasoline exacerbates asthma comes from Dr. Kevin Fennelly of the National Jewish Center for Immunology and Respiratory Medicine in Denver. Dr. Fennelly observed that some of his asthma patients got worse when MTBE was mandated in their gasoline. Denver was given oxygenated gasoline in 1988, 4 years earlier than most other cities. He applied to the EPA for funding to study this problem but the money was never given. Obviously, an epidemiologic study of this problem is imperative. Unfortunately, with one exception, l have not succeeded in inducing any of the State health departments to take the slightest interest in this problem. As I indicated, the Colorado Department of Health has been especially zealous in its promotion of oxygenated gasoline and ignored many complaints from the citizens of that State.

The one State health department that has taken my ideas seriously is Maine, where an extremely active citizen's action group is opposed to MTBE-RFG. Several legislators believe that their health has been affected and are holding public hearings. The Department of Health has initiated a study of asthma hospitalization rates in the State. Results through the first half of 1995 show no evidence for an increase in those counties using MTBE-RFG. However, due to the time lag for sensitization to occur, I would not expect to see any increase prior to the winter of 1995–96 at the earliest. One engine mechanic there developed severe occupational asthma 5 months after beginning work with MTBERFG, and he obviously has far greater exposure than does the general public.

One school nurse in suburban Philadelphia said she has seen a huge, almost an order of magnitude, increase in the number of children diagnosed with attention deficit disorder (ADD). Since many of the neurological symptoms experienced by myself and other adults are very similar (lightheadedness, difficulty in concentrating, etc.), it is not unreasonable to attribute this diagnosed condition in children to some component of MTBE-induced air pollution. It is interesting to note that national statistics indicate a great increase in drug abuse among children starting in 1992; the geographical distribution of this problem was not made known.

MTBE should have a high index of suspicion for automobile or gasoline workers with these symptoms. Mehlman[24] found that a large percentage of workers in oil refinery plants using MTBE developed the symptoms discussed here. People whose homes have attached garages may get sick from the fumes from their cars kept there. It is my suspicion that some of the symptoms attributed to MTBE in gasoline may actually be due to contamination of gasoline with TBF. This idea is supported

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[20] Sly R.M. Changing asthma mortality. Ann. Allergy 1994;73:259–268.

[21] Rachelefsky G.S. Helping patients live with asthma. Hospital Practice 1995;Nov 15:51–64.

[22] Fitzgerald S. Asthma's grip baffles the experts. (Phila. Inq. June 11, Philadelphia, 1995), pp. I -18.

[23] Nossiter A. Asthma Common and on Rise In the Crowded South Bronx. (New York Times, September 5, New York, 1995), pp. 1–2.

[24] Mehlman MA. Dangerous and Cancer-Causing Properties of Products and Chemicals in the Oil Refining and Petrochemical Industry: Part XV. Health Hazards and Health Risks from Oxygenated Automobile Fuels (MTBE). Int. J. Occupational Med. Toxic. 1995;4:219–236.

by otherwise inexplicable inconsistencies in reports from gasoline workers, such as a major change in severity of symptoms on changing the brand of MTBE-RFG.

Because of the widespread protest against MTBE, the EPA and the White House Office of Science and Technology Policy contracted a detailed review of published research by the Health Effects Institute (HEI) of Cambridge, MA. I have prepared a detailed critique of that report which is available on request from me. In general, they ignored the evidence that I sent them and misinterpreted the evidence in the public literature. This misinterpretation was due to a series of false assumptions they made about the nature of the problem, for example, that all symptoms are due to MTBE rather than to FA. A list of their fallacious assumptions is enclosed. Nevertheless, the report offers these summary conclusions:

"They [the studies] do provide an imperative for further research . . . Also to be considered is that MTBE exacerbates the effects of other health factors.

Individuals with preexisting respiratory health conditions or allergies and older people are among the groups who may be more sensitive . . . these studies provide an indication that some individuals exposed to emissions from automotive gasoline containing MTBE may experience acute symptoms such as headache or eye and nose irritation."

What is amazing is that in view of these facts, the HEI committee nevertheless concludes that [front page] "the potential health risks of oxygenates are not sufficient to warrant an immediate reduction in oxygenate use." Unless there is some overwhelming advantage to public health from the use of oxygenates, it is difficult to see how this conclusion can be derived from all of the preceding data and uncertainties.

The most important review of this question was published by the National Academy of Sciences in June 1996. They concluded that there were significant errors in some of the conclusions of the HEI report. They concluded that existing evidence clearly indicates that oxygenating gasoline does not significantly reduce carbon monoxide in winter, and that existing evidence does not rule out the possibility that MTBE usage is causing health problems. This report, which is 160 pages long, is available from the NAS. I have written a seven page summary that is available upon request.

In my opinion, this is really a problem of public health policy rather than clinical medicine. However, because of the confusing and controversial nature of the problem, more clinical input is essential. I encourage any physicians who are interested to contact me for more detailed information. I also encourage anyone interested to contact me to take part in the political movement whose purpose is to ban or reduce the level of this noxious chemical in our environment. I can be reached at the Hospital of the University of Pennsylvania, telephone number 215–662–6679. email: joseph rad.upenn.edu

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HEALTH EFFECTS FROM MTBE IN GASOLINE

PETER M. JOSEPH, PH.D.

Summary

MTBE is a chemical that is being put into gasoline under orders of the Federal Government in certain regions of the country (Regions). Many people find that it is causing them various kinds of illness. The symptoms can be either respiratory, neurological, cardiac, or allergic. Respiratory means any part of your respiratory system can be affected, including sinuses, nose, and throat, and can cause cough or trouble breathing. Asthma especially has been made worse by this problem. The neurological symptoms can include insomnia, anxiety, dizziness, nausea, headache, attention deficit disorder, or heart palpitations. The allergic symptoms include watery or itchy eyes and skin rash. The easiest way to determine if you have this problem is to travel to a region of the country where MTBE is not required to be in all gasoline and see if your condition improves. In many cases, people find that their symptoms get worse at night and on dark cloudy days without rain, but get better when the sun is shining.

What is MTBE?

MTBE is Methyl Tertiary Butyl Ether. It is a special kind of ether and is known to have effects on the brain. It contains oxygen inside each molecule, so it is used to add oxygen to gasoline. For this reason it is called an "oxygenate." The purpose of oxygenating gasoline is to reduce the amount of carbon monoxide (abbreviated CO) gas that cars produce. Carbon monoxide is a poisonous gas produced by automobiles, so the EPA (Environmental Protection Agency) is trying to reduce it to im-

prove our health. The EPA says that MTBE reduces CO by at most 20 percent, but a recent review by government scientists indicates that CO is reduced by at most 5–10 percent. That small reduction is very unlikely to be of help to anyone.

MTBE is one component of the new so-called "reformulated gasoline" (abbreviated RFG). RFG must, by definition, contain the equivalent of at least 11 percent of MTBE. However, during the last three winters certain regions of the country have been required to have gas containing 15 percent MTBE. Those regions include New York City and surrounding regions in Connecticut and New Jersey, Philadelphia and its surrounding four suburban counties, Baltimore, Washington DC, and all of California. (There may also be other cities that I am not aware of; ask your local EPA office for details.) This was done from November 1 to March 1 during the winters of 1992–93,1993–94, and 1994–95. Since January 1, 1995, all ofthese regions plus many more have been required to use RFG all year round. In most places, RFG will contain 1 1 percent MTBE, although in a few States (Washington, Oregon, Montana, and Minnesota) ethanol is used as the oxygenate rather than MTBE. Ethanol, also called ethyl alcohol, is exactly the same kind of alcohol that is used in alcoholic beverages. Again, your local EPA or State Department of Environmental Protection is the best source of information for your area.

In December 1994 Pennsylvania canceled the MTBE program in all of Pennsylvania except for the five-county Philadelphia area. However, in some areas of Pennsylvania gasoline with MTBE was still being sold even though it was not required. It may happen that the EPA will soon require that Pittsburgh use RFG again.

What are the health concerns for MTBE?

The EPA and others have done many animal experiments with MTBE. At high doses, larger than those you would normally encounter, it basically makes the animals drunk. So far, most of the animal experiments do not indicate any really bad effects from doses you are likely to receive in the air. However, some people react badly to MTBE, usually with headache, nausea, dizziness, or other signs of illness. These people will experience these problems when driving in heavy traffic or especially when pumping gasoline.

A famous scientist in Italy, Dr. Cesare Maltoni, has conducted experiments in which he showed that rats got cancer when exposed to MTBE. Some cancer experts at the EPA agree that MTBE should be classified as a carcinogen. It was not so many years ago that people thought that benzene was safe, and in fact, some automobile mechanics used to wash their hands in it. Benzene is a chemical that used to be very common in gasoline, but now we know that benzene really does cause cancer. In fact, one of the goals of the RFG program is specifically to reduce the amount of benzene in gasoline to less than 1 percent.

It is interesting to note that the 1990 Clean Air Act, which requires the use of either MTBE or some other oxygenate, also lists MTBE as a hazardous chemical whose presence in the environment should be reduced! For example, it is known to be very toxic when present in drinking water. Unlike normal gasoline, it easily dissolves in water and so is practically impossible to remove once it gets into the underground water supply.

It is also interesting to compare the toxicities of benzene and MTBE. EPA regulations require that if certain quantities of either substance are accidentally spilled, they must be reported. EPA regulation 40 CFR 302 (CERCLA Section 102) requires that any spill of more than 1 pound of MTBE must be reported, whereas only spills of 10 pounds or more of benzene must be reported. This implies that the EPA thinks that MTBE is 10 times more dangerous than benzene. In RFG gasoline they specifically require that benzene be limited to less than 1 percent, whereas they nevertheless require that RFG contain 11 percent MTBE or equivalent.

What other chemicals are involved?

Theoretically, MTBE in your gas tank should burn up inside your car's engine and leave no residue. However, no automobile is 100 percent efficient, so some MTBE does come out of the exhaust. The exact amount probably depends on how new and well tuned your car's engine is. Old cars usually emit much more pollution than new cars.

In addition to MTBE, automobile combustion also produces another chemical, called formaldehyde, in the exhaust. Formaldehyde is known to be toxic, and is considered to be a major source of air quality problems and illness when indoors. For example, certain types of cheap wood (plywood, particle board) are known sources of formaldehyde. The amount of formaldehyde emitted when MTBE is in gasoline is definitely higher than without MTBE, although the exact amount is hard to pin down. Measurements in Hartford, Connecticut indicate an increase of roughly 50

percent. Measurements in a tunnel in San Francisco showed an increase of 38 percent.

In fact, in all of the studies of automobile exhaust gases so far, there is roughly 5 percent of the exhaust that is called simply "unidentified hydrocarbons." This means that there are other chemicals being produced that have not been identified. It is most likely that among these is formic acid, since that is known to be produced when methanol is used as a fuel, and MTBE and methanol are closely related. Obviously, it is possible that formic acid could be among the unidentified hydrocarbons, but so far no one has thought to look for it. According to one medical reference book, formic acid can produce eye irritation, tearing, nasal discharge, throat irritation, coughing, trouble breathing, nausea, and skin rashes.

Once the MTBE emerges from the tailpipe, it enters the atmosphere and we breath it into our bodies. It circulates in our bloodstream and enters all of our body's organs, including the brain, liver, developing fetus, etc. The liver converts it into formaldehyde and also another chemical called tertiary butyl alcohol (TBA). In most people it does this within a time span of one to 2 hours. Formaldehyde is known to be a toxic chemical that converts into formic acid and affects the brain. As for TBA, the human body is not well equipped to detoxify TBA, and it requires approximately 1 or 2 days for it to be eliminated. During this time you may experience symptoms from the TBA in your body. You should understand that TBA is different from the kind of alcohol in alcoholic beverages; that kind is called ethanol. The healthy human body can process and eliminate ethanol much more easily than TBA; that is why a person with a lot of ethanol in his blood does not remain drunk for more than a few hours after he stops drinking.

When the MTBE is in the air, another chemical reaction also occurs; it can be converted into a chemical called tertiary butyl formate (TBF). The EPA and other MTBE proponents have totally ignored TBF. This is tragic since it is extremely irritating to the respiratory system and is probably responsible for many of the symptoms that people are experiencing. Very little scientific information is known about the toxic properties of TBF. However, it can be purchased as a research chemical, and its manufacturer gives this information on its toxic effects:

Acute effects:

- Harmful if swallowed, inhaled, or absorbed through the skin;
- Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin.
- Inhalation may be fatal as a result of spasm, inflammation and edema of the larynx and bronchi, chemical pneumonitis and pulmonary edema.
- Symptoms of exposure may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea and vomiting.

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

So, TBF and formic acid are highly toxic chemicals of the type known as "respiratory irritants." Other chemicals with similar toxic properties are known to induce asthma attacks as well as inhibit the body's natural defense against respiratory infections, such as cold, flu, pneumonia, etc. For example, the New York Times reported on January 17, 1995 that the flu was exceptionally bad in New York City and parts of Connecticut, but not in upstate New York. The areas that had a bad flu season, such as Philadelphia, were exactly those areas that have had 15 percent MTBE for the last three winters. Other cities, such as Boston, which just got MTBE in January were not as hard hit because those people have not been exposed to it as long as New York City. In December 1995 the New York Times reported that the flu had struck especially early that year, "in spades." In November 1996, the Philadelphia Inquirer reported that the flu was in full force by the middle of November and that three suburban schools had been forced to close down entirely; such a closing was historically unprecedented. Thus it appears that, at least in Philadelphia and New York City, people are less resistant to the flu than in previous years.

It is important to understand that you do not have to be in a car or at a gas station to be affected by these chemicals. They will be in the air throughout the polluted urban environment, so you can experience symptoms while at work, at home, or even in the hospital!

Who is affected?

The key idea is chemical sensitivity. Some people are much more sensitive to certain chemicals than others; this is similar to being allergic. This effect is known to exist, but the medical facts are not well understood. Unlike allergy, it can not usually be treated with antihistamines or other drugs. Evidently most people are not sensitive to these chemicals or else we would see more people being sick from

MTBE. However, it appears that approximately 5 to 10 percent of the people are sensitive to at least one of the previously mentioned four chemicals. It is possible to be sensitive to more than one.

It is well known from experience in the chemical industry that someone who is not sensitive can become sensitive to a given chemical by being repeatedly exposed to it over a long period of time. This seems to be happening with MTBE and its byproducts (TBF), because with each passing month more people are complaining about sensitivity symptoms. This can happen to anyone, but it appears to be most prevalent in people over the age of 40 (especially women) and perhaps in children with allergies or asthma.

Automobile mechanics and gas station workers who must breath MTBE and TBF fumes all day are showing more and more signs of illness. Some have become so sick they have been forced to quit their jobs.

What are the symptoms that people are reporting?

The symptoms can be roughly divided into four categories: respiratory, neurological, allergic, and cardiac.

Respiratory symptoms are due to irritation of the tissues in lungs, bronchial tubes, and nasal passages. The result feels much like a cold. Some people report sudden difficulty in breathing; that is a serious problem for which they should see a doctor as soon as possible. (Also, it is possible that the irritation produced can inhibit your body's natural defense against a true cold, although this has not been proven.) One common symptom is a long lasting cough that never seems to get better. Another common symptom is chronic inflammation of the sinuses. Also, many people with this problem just feel terrible, sort of "sick all over." A sense of hot flushing in the skin around the head and neck is common.

Neurological symptoms include nervousness, dizziness, spacey feeling, "lightheadedness," nausea, insomnia, and headache. Some people describe this as like having a cloth wrapped around your brain, or being drunk. Some people have trouble with short term memory. A common problem is difficulty in concentrating on complex tasks, such as reading a complicated newspaper article or paying attention to traffic while driving. It is possible that this is the cause of the recent increase in attention deficit disorder (ADD) in schoolchildren in MTBE regions of the country.

The allergic symptoms include watering in the eyes, discharge of fluid in the throat, or skin rash.

Some people are reporting heart palpitations from exposure to auto exhaust or on bad weather days. There have also been many reports of apparently healthy young athletes dying of unexpected heart attacks, especially on cloudy days. If you experience this sort of problem, especially late at night, you should consult a doctor. Be sure to show him or her a copy of this report, because most doctors are not aware of this effect.

Some people report that they have attacks of chest pain or heart palpitations while driving in traffic. Some scientists believe that TBF or formic acid can affect the beating of the heart through its effect on the nervous system, but this has not been proven. Nevertheless, statistics show a remarkable increase in the death rate from heart disease in New York city as soon as MTBE was mandated in 1992, and California newspapers report that some people are having heart attacks while driving through the tunnel between San Francisco and Oakland.

The symptoms you will feel will depend on which of these chemicals you are sensitive to. Actually, the details of this problem are not known, so it is hard to be more specific than this.

How do you know if you have this condition?

The respiratory symptoms are very similar to other diseases, especially to asthma or the common cold. The neurological symptoms could be caused by some other serious medical problem, such as anemia or brain tumor. You should get checked out by a doctor if you have these symptoms. There is no specific test for the MTBE condition. The best way to determine if you have the MTBE problem is to take note of what factors influence it. It is bound to be worst when in the center of a big city or near a major highway. If you can travel to another part of the country that does not require MTBE in gasoline, you can see if your symptoms go away.

Where is MTBE being used?

This is complicated, since in some States it is practically required in all gasoline, in some States it is required only in certain counties, while in other States where ethanol is being used as the oxygenate there is practically no MTBE at all in the gasoline. States using only ethanol for oxygenate include Alaska, Minnesota, Montana, Oregon, Washington, and parts of Colorado. So far, most of Pennsylvania ex-

cept for Philadelphia, Delaware, Chester, Montgomery, and Bucks counties are not supposed to have mandatory MTBE. Obviously, if you want to escape MTBE it would be good to go to a very rural area. New Jersey, Connecticut, and Massachusetts, including their shore areas, have MTBE or some other oxygenate. However, some people have reported they feel better at some of the more isolated areas of the Jersey shore, such as Cape May. North Carolina has banned all oxygenated gasoline specifically because of bad health effects from MTBE, although MTBE is still being used as an octane enhancer in high octane grades of gasoline.

If you are not sure whether MTBE is being required in your area, there are two things you can do to find out. The simplest is to just smell the gasoline at the pump, since MTBE has a very strong and distinctive odor that most people find very obnoxious. Another source of information is your local EPA office or State office of environmental protection.

Weather effects

Weather plays a very important role in the symptoms of many people with this problem. Many people find that their symptoms get much better when the sun is shining and worse at night or on dark cloudy days when it is not raining. This may be because sunlight disperses the formic acid, although this has not been proven. It is also possible that another possible byproduct of MTBE, called TON, may be involved because it is definitely destroyed by sunlight. At the present time, we do not know the exact identity of the chemical that gets worse on cloudy days.

On the other hand, if it is cloudy but raining then people usually feel better because the rain clears the air of many pollutants, including MTBE and TBF.

However, there are some people who do not get better when the sun is shining and yet are convinced that their symptoms are related to MTBE because they feel better on travel to regions without MTBE gasoline. This must mean they are sensitive to some other chemical whose nature has not yet been determined.

What about pumping gas?

Some people feel especially ill when they are pumping gasoline, and try to avoid it at all costs. The symptoms, which usually include dizziness or wooziness, can last for several hours. In several cases people have had serious automobile accidents soon after pumping MTBE gasoline. If you get symptoms only during or soon after buying gasoline, you might try to find a brand without MTBE. For example, on the east coast Getty Oil Co. usually uses ethanol instead of MTBE in the winter months. However, during the summer the EPA has forced them to use MTBE instead of ethanol.

How do we know about this problem?

MTBE was first put into gas at a high level in Denver in 1988–89. The EPA set up a "hotline" on which to take complaints. They said there were very few. However, some sensitive people living in Colorado insist that the EPA never listened to their complaints; these people have been suffering ever since! In the winter of 1992–93, MTBE was also introduced into Alaska. In the city of Fairbanks, there was a huge rise in all of the previously mentioned symptoms with almost half of the city complaining. The problem was so obvious that the EPA hired doctors from the Centers for Disease Control (CDC) to investigate. The CDC study implied that MTBE was causing the illness. Governor Hickel of Alaska ordered all MTBE out of the State, and the symptoms promptly disappeared! The CDC then did a similar study in Stamford, Connecticut and found similar problems. Furthermore, they found that the intensity of the peoples' symptoms was directly related to the amount of MTBE in their blood. In Missoula, Montana, MTBE was used as an oxygenate in 1992–93. There were many reports of the symptoms discussed here. Two-thirds of the doctors there noticed that their asthmatic patients got worse. A citizens action group organized opposition and managed to get MTBE removed from their city. The result was a dramatic decrease in these symptoms.

The EPA, however, rejected the CDC and Missoula findings and refused to allow the CDC to conduct any more investigations. The EPA is now pushing for this program to be expanded to even more States. You can call the EPA hotline at 800–621–8431 to protest this policy. However, do not expect to receive a polite answer. The most important step is to write to your senators and congresspersons and ask them to change the law that requires that we use this chemical in our gasoline.

In 1995, the White House Office of Science and Technology Policy appointed several high level committees of scientists to look into this problem.

The committee on air pollution concluded that the use of MTBE and other oxygenates has provided very little, if any, improvement in the air quality as normally determined. (They did not consider the tremendous increase in TBF in the air!) The committee on health effects wrote a rather ambiguous report in which they

admitted that people with allergies and older people may be more sensitive and recommended that more research be done. They did not consider TBF or the tremendous increase in asthma in cities where MTBE is being required.

These reports were severely criticized by a special "blue ribbon" committee of nongovernment scientists appointed by the National Academy of Sciences (NAS). The NAS is the highest body of scientific expertise in the country. The NAS report, released in June 1996, concluded that there is no evidence at all that using MTBE in gasoline is cleaning the air and may even be making ozone worse! They also indicated that they could not rule out the possibility that some people are becoming sick from MTBE in gasoline and recommended more research to see if that is true. They. also recommended that TBF be measured routinely in the air, something that has not yet been done.

Asthma

The proponents of MTBE will point out that it has been used in gasoline since 1979 with, they say, "no problems." However, asthma has been increasing dramatically over exactly that time span. The Philadelphia Inquirer on June 11, 1995 ran an article entitled "Asthma's Grip Baffles the Experts," in which they said that asthma deaths in Philadelphia had tripled since 1981, and that the cause was unknown. The article made it clear that we are now living with a real epidemic of this terrible, sometimes fatal, disease. Several newspaper reports from New York City indicate really huge increases in some parts of the city, with one school in the Bronx showing one-third of the students with asthma. On April 13, 1997 the New York Daily news ran an article that said "New York is the asthma capital of the nation." Recent statistics from the Philadelphia Department of Health indicate a 43 percent increase in asthma office visits from 1993 to 1995. Several of the asthma deaths of teenagers reported occurred in the middle of the night. Some studies indicate that formic acid increases at night. In view of the highly toxic effect that formic acid has on the respiratory system, the use of MTBE in gasoline has to be No. 1 on the list of suspected causes. Practically all schools in the Philadelphia, New Jersey, Connecticut, and New York City regions are reporting huge increases in asthma over the last few years that the asthma doctors are totally unable to explain. In Stamford, CT, the doctors noticed that the increase is worst for those children who live near Interstate 1–95 and who play under the overpasses, obviously breathing a large amount of car exhaust. The Stamford Department of Health indicates that the percentage of children there with asthma jumped from 8 percent in 1993 to 24 percent in 1996. Similarly, studies by asthma doctors in Philadelphia showed even higher percentages of children with asthma. These high percentages have never been seen before in human history, and are so high that some doctors just can't believe them! We desperately need to get more statistics on the increase of asthma in school children. There is also evidence of a huge increase in the incidence of asthma appearing for the first time in adults, something that used to be rare, because asthma usually appears first in childhood.

What can be done about this?

In many States where MTBE has been used, citizen action groups have formed to oppose MTBE. In New Jersey a group called "Oxybusters" has accumulated over 13,000 petition signatures, and in Pennsylvania so far 2000 signatures.$ However, government officials have so far ignored these petitions. That is why a letter to your elected officials is more effective than just signing a petition.

In California, the Oxybusters group has had much more success. With the support of a San Francisco talk radio station, they gathered over 62,000 petition signatures. On April 15, l 997 a bill was introduced into the California Senate to (essentially) ban MTBE. After hearing testimony from three scientists, as well as several citizens whose health has been affected, the Transportation Committee voted 7–1 to pass the ban. At present, the ultimate fate of the California ban is not yet known.

Another important activity is to somehow educate the public on the importance of this issue. This can be done by writing letters to your local newspaper. Do not expect doctors to be sympathetic, because they are usually very resistant to the suggestion that there is a new disease that they know nothing about. This is true even for those who suffer from it personally. However, after many months of seeing data and evidence they may eventually come to believe that we are right.

*California OxyBusters was organized in December, 1996 and by May 20, 1997 had collected over 80,000 petition signatures in support of legislation to remove MTBE from gasoline. The bill, SB521 is going through the legislative process as of this date.

You can also make copies of this report and distribute them to friends, colleagues, and leave stacks whereever the public gathers, such as in pharmacies or doctors'

offices. The following telephone numbers will reach Oxybusters or other citizens action committees against MTBE: California: 209–334–6538 or 415–334–6538; E-mail: acctech(lodinet.com Connecticut: 203–358–0780 Maine: 207–883–4691 New Jersey: 609–275–7080 or 609–589–6325 Pennsylvania: 610–352–7072 In addition, two Oxybuster chapters have set up web pages: http://www.lodinet.com/mtbe.htm http :/ /www.ziplink.net/dgrolfe Also, somebody at MIT has a copy of the Hartford Courant article at http://the-tech.mit.edu/V115/N38/gas.38w.html Call Dr. Peter Joseph, Hospital of the University of Pennsylvania 215–662 6679 for more information or to help in this matter.

A FEW POINTS OF FACT ABOUT MTBE

- MTBE is a poison.
- Prior to using MTBE as a gasoline additive on a massive scale in 1992, there were no adequate studies to support the safety of MTBE: this continues to be proven by the increasing reports of human illnesses and ongoing carcinogenic studies.
- MTBE in gasoline causes neurotoxic, allergic and respiratory illnesses.
- Toxicological studies do NOT support the safety of MTBE.
- MTBE from gasoline and its metabolites accumulate in human blood.
- TBA, a MTBE metabolite, causes cancer in experimental animals.
- MTBE causes an increase in concentrates of formaldehyde in the air. Formaldehyde is a carcinogen that causes leukemias and lymphomas.
- MTBE in gasoline does not statistically significantly reduce blood benzine levels in humans.
- Oil refining workers and consumers are getting sick when exposed to MTBE.
- MTBE causes cancers in many organs and tissues of two species of experimental animals. These cancers are identical to those caused by exposures to of the same dose to benzene, vinyl chloride and 1.3 butadiene, all known carcinogens. There is general agreement among experts in chemical carcinogens that a substance which causes cancer in a significant number of experimental animals in well conducted assays poses a presumptive carcinogenic risk to some humans, even in the absence of confirmatory epidemiological data. There is no recognized method as yet for establishing the existence of a threshold for a carcinogen in the human population. These principles, which are accepted throughout the world, have served for many years as the basis for sound public health policy and regulatory action on carcinogens.
- MTBE causes leukemias and lymphomas, testicular, kidney and liver cancers in test animals.
- MTBE is most likely immunotoxic to humans (tests are under way).
- MTBE does not reduce CO exceedences of above 9 ppm as was proposed (New Jersey, Alaska, North Carolina).
- Industry claims that few areas experience toxic symptoms from MTBE is FALSE.
- MTBE is not magic. "It is my opinion after review of the scientific literature and of the numerous Oxygenated Fuels Association advertisements, the EPA was mislead by industry officials who misrepresented the safety of MTBE without the support of adequate studies. A good example of this is kidney cancer. In this case the industry assured the EPA that kidney cancer was caused by a special mechanism of action (2ug globulin) which they alleged was not relevent to human cancer. Upon testing, however, this turned out not to be the case. Consequently, the Agency misclassified the cancer risk from MTBE. In due time this mistake will be corrected." (Dr. Myron E. Mehlman, Ph.D.)
- Interpretetions and conclusions by scientists from consulting corporations and universities paid by the oil industry concerning the safety of MTBE is FALSE!
- "The greatests tragedy is that all of the adverse health effects from exposure to gasoline containing MTBE could have been avoided. It is apparent that there has been deliberate experimentation on unknowing and unsuspecting citizens of our country." (Dr. Myron E. Mehlman, Ph.D.)
- MTBE is not the only source of problems. Its metabolites, created when it is burned in automobile engines, include formaldehyde, TBF or TBA and toxilogical symptoms correlate with blood [MTBE and metabolites] levels.
- Ambient TBF levels are sufficient to create problems.
- Respiratoty infections are made worse by TBF.
- Drastic increases in asthma cases correlate precisely with the use of MTBE in gasoline.
- Toxic symptoms disappear when people leave areas where MTBE is used.
- With the addition of MTBE, more gasoline is used and thus has a greater impact on environmental degeneration.

- MTBE in gasoline causes leaks in gas tanks and underground storage tanks.
- MTBE causes deterioration of automotive fuel systems.
- MTBE in gasoline reduces mileage per gallon.
- MTBE dissolves in water and very difficult to remove. This will result in drastic increases in the cost of water in districts with MTBE contaminated water supplies.
- MTBE is being found in significant quantities in water supplies.
- MTBE in very small concentrations in water adversely affects it taste and in very moderate quantities makes it undrinkable.
- MTBE in irrigation water could destroy our agricultural industry if other States and countries refuse to buy California produce. Dairy and animal products would be similarly affected.

Many points in this list are taken from a letter dated March 29, 1995 written by Dr. M.A. Mehlman to Fred Craft, Executive Director, Oxygenated Fuels Association, Inc. Washington, D.C. Dr. Mehlman is editor of the journal Toxicology and Industrial Health and is a consultant to the Oil, Chemical and Atomic Workers union. He has surveyed over 800 people in New Jersey in regards to MTBE and its erects on them. Dr. Mehlman is Adjunct Professor of Public Health, Robert Wood Johnson Medical School, Piscataway, NJ. (609) 683–4750. Other points are taken from various news reports and other previously published writings of Dr. Peter M. Joseph.

STATEMENT OF THE OXYGENATED FUELS ASSOCIATION

This statement is presented to the Environment & Public Works Committee of the United States Senate by the Oxygenated Fuels Association (OFA) in response to the field hearing conducted on December 9, 1997 in Sacramento, California concerning methyl tertiary butyl ether (MTBE). OFA is a national trade association established in 1983 to advance the use of oxygenated fuel additives. These additives not only improve the combustion performance of motor vehicle fuels, thereby significantly reducing automotive emissions and air pollution, but also replace or dilute many of the toxic compounds historically associated with gasoline emissions.

OFA member companies produce and market the majority of the United State's oxygenate compounds for use in cleaner burning, reformulated gasoline (RFG) and pollution fighting wintertime oxyfuels, including California's clean-burning gasoline program. The oxygenate of choice, both in California and nationwide, is MTBE—the prime pollution fighting component in clean burning CARB II and reformulated gasoline.

Our membership appreciates this opportunity to present the views of OFA with respect to the committee's questions concerning MTBE and its role in the RFG and cleaner burning gasoline programs. We request that this written statement become part of the official record of this proceeding.

This inquiry represents a clear case of right time, right place and right agenda. The highway of history has brought energy, health and environmental concerns to a crossroads where we are left with two choices—a head-on collision, or some common sense cooperation.

What better time to arrive at this intersection than here and now?

The time is the relative beginning of the reformulated and cleaner burning gasoline programs, giving us a large enough window of opportunity in which to protect our air and water resources while assuring our ability to produce and distribute the fuels that are so vital to this nation's future.

OFA's purpose in submitting this statement is not to complain that MTBE is misunderstood or unfairly abused about its impact on the health and environment, especially by a few entities in the State of California. OFA is not submitting this statement to inflame the debate about who is the bad guy in this story. Instead, we would like to substitute reason for emotion. To do that between now and the end of these remarks, OFA will state and attempt to support four points.

The first thing we will say is that we are still in the crisis enrichment stage of the RFG program. That means we know what we do not know, and lacking definitive knowledge there is a temptation to imagine the worst, overcorrect the problem, and do considerable damage to our energy, environmental, and economic needs.

The second thing OFA will convey is that we are practicing guilt distribution. While attempting to deflect or conceal the real problems affecting a few ground and surface water resources, again mostly in California, it has been decided by a vocal few that MTBE is the culprit. If we can just eliminate it as a constituent in gasoline, our lives will be enriched and risk-free.

The third point OFA will make is to issue a plea for balance. This nation's political, business and public interest leaders and policy makers have come a very long

way to recognize that production of energy and protection of environment and health are no longer mutually exclusive. We need to recognize the contradiction between the shouting that our water is poisoned, and our air is fouled—and the reality that we are now healthier and enjoy longer lives than human beings ever have.

And the fourth point we will emphasize is the need for all of us to come to our senses—in this case, a sense of purpose, a sense of timing, and a sense of cooperation. We all want a healthy environment and affordable energy. To whatever extent RFG, MTBE and the supply and distribution system plays to affect those goals, we have the time and the talent to create the solutions that will keep us on the course we can all live—and breathe—with.

So, what is MTBE? Methyl Tertiary Butyl Ethyl is an octane enhancer and cleaner burning octane alternative to lead and aromatics. MTBE was first commercially used in Europe in 1973. It has been used in the United States since 1979 and in California for over 12 years—since 1986. It is now the principal pollution fighting ingredient in RFG.

RFG is sold year-round in about 32 percent of the U.S. gasoline market, throughout 17 States with the worst air pollution problems. According to U.S. Environmental Protection Agency estimates, since its introduction in January 1995, RFG has eliminated approximately 300 million tons of pollution from the nation's atmosphere. In California, reductions in vehicle emissions including VOCs, NO_X, SO_2 and CO due to cleaner-burning gasoline are equivalent of removing of 3.5 million vehicles from the State's roads. In addition, California's level of highly toxic benzene from fuel exposure has been reduced by 50 percent.

The result of this program is that the citizens of California now enjoy the best air quality not just in years, but also in decades. Enclosed as Attachment I is a California Air Resources Board (CARB) report entitled "Cleaner-Burning Gasoline: An Assessment of Its Impact on Ozone Air Quality in California," issued in October 1997. The study examined the improvements in ozone air quality due to RFG in three major areas of the State, namely, the South Coast Air Basin, the Sacramento Metropolitan Area, and the San Francisco Bay Area.

After factoring control strategies for emissions other than from vehicles and for meteorology, the CARD findings are significant in that cleaner-burning gasoline, with MTBE as its principal pollution fighting additive, is directly responsible for the following ozone improvements:

—11 percent improvement in the South Coast Air Basin

—12 percent improvement in the Sacramento Area

In the nation-wide market, MTBE comprises approximately 80 percent of the volume of oxygenate required to produce RFG. Most of the remaining 20 percent are ethanol used primarily in the Midwest where State incentives exist. The reasons are easily explained. Simply stated, air quality restrictions, refinery operating requirements, state-of-the-art blending practices, ease of supply and distribution and basic economics dictate MTBE as the oxygenate of choice for most areas requiring cleaner burning gasoline.

Similarly, in the regions of the country where other oxygenates are used, the additives of choice for local rehmery operations are determined by the same economic and logistical issues.

Concerning the first of the four points we wish to emphasize to the committee—in the U.S., and particularly in California, we are very much into the crisis enrichment stage on this matter. An intense public debate, fueled by the pseudo science of radio talk show commentary and exacerbated by misleading and inaccurate press reports, continues among political, economic and commercial circles regarding MTBE. An outburst of emotional alarm, based on anecdotal and unsubstantiated claims concerning health and environmental impacts of MTBE, remains the focus of attention.

However, the facts concerning MTBE and health prove different. MTBE is one of the most extensively tested chemicals ever introduced in modern commerce, amounting to approximately 80 health studies since 1969. Assessments of these studies generally concluded that the use of MTBE as a gasoline additive poses no increased risk of health effects over conventional gasoline. In fact, the addition of MTBE to make gasoline burn cleaner results in lower vehicle emissions which, in turn, contributes to improved public health by limiting human exposure to air pollution.

The White House's Office of Science and Technology Policy (OSTP), in its Interagency Assessment of Oxygenated Fuels Report, concluded chronic, non-cancer health effects (neurological development or reproductive) "would not likely occur at environmental or occupational exposures to MTBE." In California, the California Air Resources Board (CARB) credits the State's clean gasoline program for reducing the public's exposure to cancer risk by 40 percent. In terms of encroachment of MTBE into drinking water sources, the OSTP report noted that " . . . the consumption of

drinking water was not a major route of exposure . . . " for MTBE, based on the available monitoring data collected so far. The OSTP report farther noted that most detection of MTBE was below the lower limit of a previous draft EPA health advisory of 70 parts per billion (ppb).

While the U.S. has led the world in MTBE studies, other parts of the globe have also conducted research into the health effects of MTBE. For instance, The European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) has concluded: "the risk characterization for MTBE does not indicate concern for human health with regard to current occupational and consumer exposures." ECETOC also concluded: "MTBE is not carcinogenic according to the criteria (set forth in the European Union's) Directive on Dangerous Substances." Dr. Nancy Balter, Principal with the International Center for Toxicology and Medicine, presented formal testimony at the field hearing and her final statement is enclosed, labeled as Attachment II.

What we have done in California and as a nation is to identify what we think is a problem, gone through the initial response of over-reaction, and are now, hopefully, moving toward a more measured approach.

California recently enacted legislation that calls on the University Of California to perform additional studies—a requirement that OFA both applauds and supports. The oxygenates industry is confident that sound, objective science will demonstrate, once again, that MTBE benefits human health and the environment when properly used by significantly reducing air pollution.

The second point we mentioned is that the process of guilt distribution is underway. Finding someone to blame. Who are the good guys and who are the bad guys? This phenomenon has been exacerbated as stories abound concerning the contamination of California's water resources.

MTBE has been detected in some sites in California, mostly at levels far below any potential to harm human health or welfare. In a few instances, however, the levels of contamination have been substantial and have precipitated quick and appropriate responses from civic authorities.

OFA firmly believes that MTBE and the other hundreds of components of gasoline should never be in the water table or in surface waters. Releases or leaks from underground gasoline storage tanks or pipelines are the main causes of MTBE entering groundwater sources. The presence of MTBE in groundwater is a strong indicator that other toxic gasoline components, such as the known human carcinogen benzene, have also entered the subsurface.

OFA further believes the responsible parties for leaking tanks or pipelines, whether industrial, commercial or municipal, should bear the financial burden of emergency response, cleanup and remediation for such events.

OFA supports Federal and California requirements for upgrading underground tanks and related improved leak monitoring programs, which must be in place for all gasoline storage sites by December, 1998. Sites that had previous leaks or spills must also be cleaned up by this deadline. Failure to meet these requirements will result in closure of these sites. We support these programs and applaud the State of California for its leadership in this vital environmental effort.

In addition, statements have been made suggesting that the "corrosive" nature of MTBE is the main cause for the failure of underground storage tanks and thus responsible for the leakage of gasoline into certain ground water resources. These statements, at best inaccurate, further demonstrate the need for balance and reason. As a supplement to this statement, the committee will find several documents completely dispelling the notion that MTBE is the causal agent in the leaking or failure of underground fuel tanks. The first, labeled Attachment III, is a paper entitled "MTBE Compatibility with Underground Storage Tank Systems," prepared by James M. Davidson of Alpine Environmental, Inc. Among the many conclusions of the scientific study that debunk the theory that MTBE is the culprit in the tank leakage problem are the following:

"All information indicates that MTBE is compatible with underground storage tanks and piping made from fiberglass."

"All available testing of numerous seals indicated they were compatible with the maximum MTBE concentrations allowed by law in gasoline (i.e. 15 percent MTBE volume/volume)."

"No scientific basis could be found to support claims that MTBE may be causing UST leaks due to incompatibility with glues used in fiberglass UST systems, or due to incompatibility with vapor recovery systems."

The second document (Attachment IV) concerning tank compatibility with MTBE is a paper written by Sullivan D. Curran, Executive Director of the Fiberglass Tank & Pipe Institute. The paper discusses the compatibility of gasoline and gasoline-oxygenate blends. Also included (Attachment V) are warranties for double-wall under-

ground petroleum storage tanks provided by Fluid Containment, Inc. and Xerxes Corporation, two leading manufacturers of underground storage tank systems. These warranties each expressly provides a thirty (30) year guarantee for oxygenated motor fuels containing up to 20 percent (by volume) of MTBE.

That brings us to the third point—a call for balance and middle ground. It is time to eliminate the rhetoric; to look at what is possible and probable—to be reasoned and reasonable.

As a practical matter, MTBE is essential in making the CARB II and Federal RFG gasoline necessary to meeting clean air requirements with the huge California demand for gasoline. Californians use 35–37 million gallons of gas per day, or about 13 billion gallons per year. The existing refinery configurations and available supply of other oxygenates are not adequate to replace MTBE and still meet this huge demand. The needed changes would require additional massive investments to retool rehmeries, build oxygenate capacity, and in some cases add transportation and distribution facilities.

The oxygenate and oil industries have already spent more than $3 billion in California for capital expenditures for Clean Air Act compliance based upon what they identified as the only viable means of compliance.

OFA firmly believes that it is unwise to consider alternative oxygenates that have not undergone the same kind of rigorous scientific scrutiny applied to MTBE. The fact is MTBE is one of the most studied compounds ever to be introduced into modern commerce. As previously stated, no fewer than 80 health studies have been completed to date, which collectively demonstrate that MTBE is not harmful when used for its intended purpose—as an anti-pollution additive in gasoline. According to the President's Office of Science & Technology Policy (OSTP), health studies, including controlled exposure studies, have shown that persons are not at increased risk of experiencing acute health effects. The National Academy of Sciences, in a review of the OSTP report last June, concluded that MTBE appears "not to pose a substantial human health risk." The Health Effects Institute said "adding oxygenates is unlikely to substantially increase the health risks associated with fuel used in motor vehicles; hence, the potential health risks of oxygenates are not sufficient to warrant an immediate reduction in oxygenate use at this time." With 80 studies, needless to say, there are many other excerpts that could be quoted. To phase it out—particularly in favor of less thoroughly tested additives (or return to more-polluting conventional gasoline)—makes no sense.

The current debate over the use of MTBE, especially in California, can not, and should not, devolve into the notion that this is a choice between clean air or clean water. It is true that some water resources have been contaminated, raising legitimate questions about MTBE, its health effects and encroachment into water supplies. On October 20, 1997, the California Department of Health Services reported that out of 2,268 drinking water sources sampled, 28 had detections of MTBE. Santa Monica and Marysville had findings exceeding the State action level of 35 ppb. It is critical that these issues are thoughtfully and responsibly addressed, and the California legislature has taken action to do so.

The real issue of course is that gasoline does not belong in the water and if it ends up there it should be cleaned up. It became popular to say that MTBE could not be cleaned up in the water. But that is, quite simply, not true. MTBE can be remediated with existing and effective technology. It can be more expensive than cleaning up benzene, for example, however, in many cases these costs are within reason. A paper prepared by Michael C. Kavanaugh, P.E., Ph.D., Vice President of Malcome Pirnie and an expert in remediation, water treatment technology and associated costs, is enclosed as Attachment VI.

The California legislature recently passed and the Governor signed three bills to address the benefits and concerns related to MTBE and other oxygenates. These bills call for extensive study and evaluation; direct the establishment of drinking water standards; require identification and monitoring of potential sources of water contamination, and expedite the remediation of gasoline spills and leaks. A fourth measure passed by the California legislature and signed into law by the Governor prohibits the delivery of any petroleum products to tanks not in compliance with the new standards. OFA supports these measures and particularly looks forward to the anticipated exoneration of MTBE through the studies required. Both Wisconsin and Maine have already gone through a similar process and reached the conclusion that MTBE is safe as it is used in gasoline and indeed provides tremendous health benefits through its cleaner burning gasoline properties.

Our fourth and fmal point sums up the other three. It is an appeal to develop our senses. The first of these is a sense of purpose. We should understand that most everything begins with energy. Nearly everything we do as a civilization has a direct link to energy. RFG and cleaner-burning gasoline, with MTBE as the additive

of environmental and economic choice has a huge role in that equation. Our purpose must be to fmd the best way to use it as intended, not the most expedient way to condemn it.

One more sense we should promote is that of mutual cooperation. A sense of understanding that health and the environment are everyone's concern. No one has exclusive claim about clean air and water.

OFA appreciates the fact that individual States, including California, have not allowed themselves to be swayed by false claims and innuendoes. We trust the U.S. Congress will likewise render similar judgement. We are absolutely convinced that sound science, facts, and demonstrated results do and will continue to prove the efficacy of MTBE as a safe, effective pollution fighter.

California is enjoying the finest air quality the State has experienced in over 4 decades, and we are very pleased to be a part of that substantial achievement.

ADDENDUM

1. Supply and Demand

The current demand for gasoline in California is approximately 950,000 barrels per day (bid). Both CARB II gasoline and Federal reformulated gasoline (which is required to be used in certain Federal nonattainment areas of the State) need the addition of oxygenates to work. The State's gasoline sales are split about two-thirds Federal reformulated gasoline and one-third CARB II gasoline. Because it is the least expensive, most plentiful, and highly effective alternative, more than 90 percent of the oxygenate compounds used in California are MTBE, totaling approximately 96,000 bid. Most of the other oxygenate used in California is TAME, a coproduct manufactured within some refineries in limited volumes.

The use of oxygenates like MTBE in the volumes discussed has a beneficial impact on the total supply of motor fuels throughout California.

By adding MTBE or other oxygenates to gasoline, the total gasoline supply is increased. This helps stabilize the price of gasoline.

2. Limitations of Ethanol in California

There are a number of reasons why ethanol can not materially replace MTBEin California, including availability, logistics, economics and environmental problems. In terms of logistics, for example, ethanol must be splash blended at individual terminals, requiring drastic changes to the logistical infrastructure across the State.

According to an analysis by Dewitt & Company, Inc., the US production of ethanol is approximately 70,000 bid. Of this 23,000 bid are used for Clean Air Act (CAA) purposes (i.e. making Federal RFG) in PAD II; 17,500 bid for oxyfuels (wintertime use); and 27,000 bid used in the Midwest (encouraged by additional State subsidies). Thus, there is inadequate additional ethanol capacity for the California market (which would need an additional 50,000 bid of ethanol). To meet the full California need, new ethanol plants must be constructed, requiring an investment of at least $1.5 billion.

With regard to transportation, ethanol can not be transported by pipeline, so it must be railed or trucked in—an expensive proposition, especially since every tank must be completely dry because of ethanol's affinity for water. The committee should consider whether there would be enough rolling rail stock (tank cars) to support a massive deployment of ethanol from Midwestern processing plants to California, especially during the current difficulties in the railroad transportation system plaguing all of American industry. Use of ethanol would force California to rely upon the railroads for a significant amount of its ethanol requirements.

Then there is the question of ethanol's impact on the integrity and overall effectiveness of California's air pollution program. Because of ethanol's higher blending vapor pressure, it is more volatile than MTBE and can not be used without violating Federal Volatile Organic Compounds (VOC) standards, or making costly adjustments to the base gasoline stock. The National Academy of Science is continuing to study the ozone forming potential of ethanol based fuels.

Therefore, for all these reasons, it is a practical impossibility to get enough ethanol into California as a substitute for MTBE. The bottom line is clear, from availability, cost, transportation and infrastructure points of view, ethanol is not a viable alternative to MTBE.

3. Bilbray Legislation

The Clean Air Act Amendments of 1990 required the use of a Federal RFG that contains a minimum 2.0 percent oxygen content by weight in ten cities (and surrounding areas) which have the most serious ozone pollution levels. Due to the tight

statutory deadlines placed on EPA for the development of regulations and guidance to the States along with the overall complexity of the issue and the level of public interest, a regulatory negotiation or "REG-NEG" committee was established. This committee compromised most affected stakeholders, including Federal and State governments and various affected industries and environmental groups. An historic agreement that formed the basis for the oxygenated fuels and reformulated gasoline program was signed by most of the participants on August 16, 1991.

California, having additional clean air problems throughout the State, further restricted the use of conventional gasoline. The State adopted a "cleaner-burning" gasoline program that would include all areas of the State not covered by the Federal RFG program. This gasoline, known as CARB gasoline, does not require the use of oxygenates to meet the prescribed emissions parameters. The cities of Los Angeles, San Diego and Sacramento and the San Joaquin Valley are among the areas required by Federal mandate to use oxygenates in California's "cleaner-burning" gasoline. These areas and their demand for fuel suggests that approximately two-thirds of all gasoline sold in California must contain oxygen at a 2 percent minimum.

Legislation has been introduced by Congressman Bilbray that would give California rehmeries the "flexibility" to maintain its fuel emissions standards without having to meet the Clean Air Act mandated 2 percent oxygen requirement. OFA remains in opposition to this legislation. However, the merits (or lack of them) concerning the Bilbray legislation must not be part of this debate concerning the efficacy of MTBE in gasoline, its detection in groundwater or purported health effects. The issues are unrelated and while several attempts to join them have been attempted, the motives to do so are, at best, disingenuous. Enactment of Bilbray-type legislation will not solve the problem of gasoline and all its constituents leaking from underground storage tanks. Further, most proponents of the Bilbray legislation acknowledge the importance of MTBE in California's remarkable achievements in air quality and its necessity to remain a prominent component of CARB II gasoline.

Enclosed as Attachment VII is an article entitled "MTBE Concerns in California" that was published by DeWitt & Company in their December 11, 1997 "MTBE/Oxygenates/Clean Fuels" Newsletter. In this article, Dewitt & Company, recognized experts in the fuels and refinery sectors, describe in detail the lack of relationship between the Bilbray legislation and the overall issue of MTBE in California gasoline.

ATTACHMENT I

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY AIR RESOURCES BOARD
TECHNICAL SUPPORT DIVISION
AIR QUALITY DATA BRANCH
CLIENT SUPPORT SERVICES SECTION
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CLEANER-BURNING GASOLINE: AN ASSESSMENT OF ITS IMPACT ON OZONE AIR QUALITY IN CALIFORNIA

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The opinions, findings, and conclusions expressed in this paper are those of the staff and not necessarily those of the California Air Resources Board.

SYNOPSIS

California's cleaner-burning gasoline was introduced statewide in early 1996. As the most significant ozone-reducing measure in California since 1975 when vehicle emission standards were adopted that required catalytic converters, cleaner-burning gasoline provided significant emission reductions almost overnight. Because the shift to cleaner-burning gasoline occurred over such a shorteriod, the impact on ozone levels in 1996 was expected to be discernable. This paper describes an effort to determine whether a measurable change in ambient ozone concentrations could be detected.

The Air Resources Board staff analyzed ozone concentrations for the smog season (May through October) for the South Coast Air Basin, the Sacramento Metropolitan Area, and the San Francisco Bay Area Air Basin. The results show overall reductions in ozone of approximately 18 percent and 14 percent for the South Coast and Sacramento regions, respectively, after adjusting for meteorological differences between 1996 and years prior to the introduction of cleaner-burning gasoline. The results for the Bay Area are less conclusive; the analysis showed a modest overall im-

provement of approximately 4 percent in ozone in 1996, when compared to l995 and 1994. It is necessary to adjust for meteorology because different meteorology from day to day and year to year can produce different air quality even if emissions remain constant.

The improved ozone reflects the cumulative effects of all State and local air quality measures including new motor vehicle emission standards. However, cleaner-burning gasoline was responsible for most of the emission reductions experienced in California in 1996. Therefore. it is reasonable to attribute the majority of the observed improvment to this program Based on emission inventory data, it is estimated that the introduction of cleaner-burning gasoline accounted for over half the ozone improvement in 1996. This analysis estimates that cleaner-burning gasoline accounted for about an 11 percent improvement in ozone in the South Coast, a 12 percent improvement in ozone in the Sacramento area, and a 2 percent improvement in ozone in the Bay Area.

This paper presents the methodology used by the staff and the results of the analysis.

DESCRIPTION OF METHODOLOGY

The discussion below addresses the regions and time periods analyzed, the ozone data used, the meteorological factors selected, and the analytical methods applied.

What regions and time periods were analyzed?

This analysis addressed three regions of California—the South Coast Air Basin (Los Angeles Area), the Sacramento Metropolitan Area, and the San Francisco Bay Area Air Basin Each of these regions has a relatively dense network of ozone monitors that operated both before and after introduction of cleaner-burning gasoline. In addition, these three regions had sufficiently complete meteorological data to support the detailed analysis that was required.

Ideally, the impact of cleaner-burning gasoline on ozone air quality would be assessed by comparing the ambient ozone concentrations from the most recent years before the new gasoline (1994 and 1995) to the concentrations after the introduction of the new gasoline (1996). For the San Francisco Bay Area and the Sacramento Metropolitan Area, this approach was used.

In the South Coast Air Basin, a different baseline period was needed because Federal Reformulated Gasoline was introduced in 1995. Because this analysis was not focused on changes in emissions due to the Federal program, the 1996 ozone data were compared to the 1993/1994 ozone data in the South Coast Air Basin. By using this approach, the introduction of Federal Reformulated Gasoline did not mask the effects of cleaner-burning gasoline.

What odor data were used?

The daily maximum ozone concentration is an important parameter from a public health perspective. For each year and region used in the analysis, the daily maximum ozone concentrations were used to represent regional ozone. The data for the daily maximum ozone concentrations were taken from the ARB's database for measurements that satisfy the criteria for "data for record".

Why should meteorology be considered?

Differences in meteorological conditions affect the concentrations of air pollutants strongly from day to day and, to a lesser e dent, from year to year. Even when emissions of pollutants do not change, differences in meteorological factors such as winds, temperatures, and sunlight can cause pollutant concentrations to differ greatly. Accordingly, an analysis of the impact of cleaner-burning gasoline on ozone concentrations needs to consider meteorological differences that affect air quality data used to represent conditions before and after the introduction ofthe gasoline.

Although existing information does not allow for complete accounting for weather effects, the methods used in this analysis to adjust for meteorology are thought to remove the majority of the weather effects and provide a valid way of determining emission impacts.

What meteorological measurements were used?

Scientists have studied meteorology and air pollution, especially ozone, for many years. In studies around the world, surface ozone formation increases when precursors accumulate near the ground on days with intense sunlight and high temperatures. In many cases, certain meteorological measurements have been found to be Icey indicators of these conditions and, therefore, key indicators of ozone forming potential.

Three types of routine meteorological measurements are often useful indicators of ozone forming potential in many areas of California. They are air temperatures sever al thousand feet above the ground, temperatures at the surface, and wind speeds at the surface. These indicators, individually or in combination, can often "explain" much of the day-to-day variation in ambient ozone concentrations associated with the weather Figures l(a)-1(c) use data from the Sacramento Metropolitan Area for 1994 through 1996 to illustrate the relationships between these three meteorological factors and daily maximum ozone in the region.

Figure 1(a) shows the relationship between daily maximum ozone and the temperature of the air five thousand feet above the ground: Air temperatures aloft because they determine the height and strength of inversions that limit the volume of air in which pollutants can muc As temperatures aloft increase,.pollutants including ozone and its precursors—tend to accumulate near the ground. As Figure 1(a) shows, higher temperatures aloft usually indicate higher ozone forming potential. The relationship shown in Figure 1(a) is nonlinear, and it is not surprising that a second order term (e.g., X^2) is often needed when using temperatures aloft to help explain differences in daily ozone.

Figure 1(b) shows the relationship between daily maximum ozone and daily maximum air temperature near the ground. Surface temperatures can be effective surrogates for solar intensity while they measure temperature directly, solar intensity and temperature are important because the photochemical reactions that produce ozone work faster as sunlight and temperature increase. Higher surface temperatures usually indicate greater ozone forming potential. The relationship shown in Figure 1(b) is also nonlinear, and a second order term is usually important when using surface temperatures to help explain differences in daily ozone.

Figure 1(c) shows the relationship between daily maximum ozone and surface wind speeds. Surface wind speeds are important because winds can help disperse pollutants and can increase the volume of air available to dilute pollutants; in general the higher the wind speed the lower the ozone potential. Although the relationship shown in Figure 1 (c) is nonlinear, a first order term is omen sufficient to incorporate the effect of wind speed on differences in daily ozone.

In different areas of the State, temperatures aloft, surface temperatures, and wind speeds may differ in their relative importance for explaining differences in daily maximum ozone concentrations. Nevertheless, some combination of these three meteorological factors accounts for much of the variation in the daily maximum ozone concentrations throughout the ozone season in each of the three areas of California that were analyzed.

Table 1(a) identifies the specific variables that were used in the equations that relate meteorological conditions to daily maximum ozone concentrations in each of the three regions analyzed. For the South Coast Air Basin, the combination of variables did not include wind speed because it did not significantly increase the ability of the equation to explain the daily maximum ozone concentrations in that re zion. Nevertheless, wind speed was included in the equations used for the Sacramento Metropolitan Area and the San Francisco Bay Area Air Basin.

How were the meteorological data applied?

In concept, if emissions remain relatively unchanged from one year to the next, then days with similar meteorology should produce similar maximum ozone concentrations in both years. To confimn this, days with similar meteorology first need to be grouped together. Then, similar days in the first year are compared with similar days in the second year to determine whether there is a difference in ozone. Differences in ozone then most lilcely indicate a change in emission levels. The actual steps are briefly described below.

First, maximum hourly ozone concentration data and meteorological data were collected for each day of the ozone seasons in the baseline years (before cleaner-burrung gasoline) and in 1996 (after cleaner-burning gasoline). The ozone season is defined as May through October.

Second, the data for the baseline years were used to develop an equation for each area that integrates the effects of daily meteorological conditions—air temperatures aloft, surface temperatures, and wind speeds. These equations were then used to quantify the ozone forming potential of all days in the ozone season. The days were then grouped by similarity of their ozone forming potential. We refer to these groups as meteorological categories or simply "categories" in this paper. The equation developed for each area is shown in Table 1(b).

Third, it was observed that the number of days that fell in each meteorological category (i.e., the frequency distribution of ozone forming potential) was different for each year. For example, some years had more days that were conducive to the formation of high ozone than other years. In order to separate the effects of emissions

and meteorology on ozone concentrations, we must first level the meteorological playing field. To allow comparison of ozone levels in one year with ozone levels in another year, both years need to have the same frequency distribution of ozone forming potential. Therefore, a standard or "typical" ozone season was established based on a representative mix of the meteorological categories.

Table 2 shows the actual frequency distributions of categories for 1994, 1995, and 1996 in the Sacramento Metropolitan Area. The frequency distributions for the 3 years were averaged together to produce a "typical" ozone season frequency distribution. An example of this averaging method is shown in conjunction with Table 2.

Fourth, the average of the daily maximum hourly ozone concentrations for the days in each category was calculated. This was done for each year. The results for the Sacramento Metropolitan Area are shown in Table 3.

Fifth, all categories whose ozone forming potential exceeded the State ozone standard were identified. With these categories for each year, the average ozone concentrations were weighted together to produce an annual, meteorologically adjusted. average ozone. The weighting factor for each category was its typical frequency determined in the three above. Only those categories whose ozone forming potential exceeded the California l-hour ozone standard (0.09 ppm) were used because the elects of differing emissions (the focus of this analysis) are most discernable when the meteorological conditions lead to ozone concentrations well above the prevailing "background" concentrations. For the Sacramento Metropolitan Area, categories and above were used for calculating the annual weighted averages. The results are shown at the bottom of Table 3.

Finally, the annual weighted averages were used to estimate the impacts of emission reductions on ozone air quality before and after the introduction of cleaner-burning gasoline.

PERFORMANCE OF THE METHOD

How well did the procedure account for meteorological effects?

Although the analyses were necessarily limited by the amount of meteorological data and the level of detail that could be pursued, the procedure was effective according to the most commonly used objective measure of performance—"R-squared".

For example, Figure 2 shows graphically the effectiveness of the equation relating meteorological conditions and daily magnum ozone concentrations for the Sacramento Metropolitan Area In the figure, the meteorological categories are plotted on the x-as in order of increasing ozone forming potential, and the measured ozone concentrations for the baseline data (1994 and 1995) are plotted on the y-ams. Each dot represents one day during the 1994 or the 1995 ozone season. The relationship shows a strongly increasing trend with an it-squared value of approximately 0.70. That is, the meteorological categories account for 70 percent of the variation in the daily magnum ozone concentrations during the May-October ozone season. This performance is excellent when compared to other efforts to explain ozone concentrations based on meteorological data The R-squared values for the other two regions were as good as or better than the R-squared value for Sacramento.

The 30 percent of the variation that is not explained by the equation may be due in part to to variation in emissions between 1994 and 1995 and to meteorological factors that the equation did not include. For example, carryover of ozone from the previous day can inc ease daily maximum ozone concentrations significantly, but no direct measurements of carryover are routinely available and estimates of carryover may be subject to high uncertainty.

Was it necessary to account for meteorology?

Table 2 illustrates the need to account for meteorological effects. As the table shows for Sacramento, 1994 differed greatly from 1995 and 1996 us the frequencies of the two categories with the highest ozone forming potential—categories 11 and l2. In 1995 and 1996, these categories had 6 days and 5 days, respectively, while 1994 had none. Because 1994 lacked the more "extreme" meteorological

conditions, the unadjusted average ozone concentrations were lower for the season. Without adjusting for meteorology, the lower average ozone in 1994 might be attributed to lower emissions instead of more accurately being attributed, in large part, to the weather.

RESULTS

What are the estimated improvements in overall ozone after adjusting for meteorology?

Table 4 summarizes the results of the analysis. For each region, the table shows the average ozone (for days with potential to exceed the State ozone standard) for

the baseline years and for 1996 after adjusting for most of the meteorological effects. The table also shows the percent improvement in the average ozone from the baseline years to 1996. The improvements represent changes in ozone due to reduction in emissions from all sources, not just to cleaner-burning gasoline.

For the South Coast Air Basin, the baseline years were 1993 and 1994. As noted earlier, the introduction of Federal Reformulated Gasoline in the South Coast during 1995 made it necessary to use the two earlier years as the baseline from which to estimate ozone benefits due to California's cleaner-burning gasoline. As shown in Table 4, the improvement in the average ozone from the baseline years to 1996 was 18 percent after adjusting for meteorology.

For the Sacramento Metropolitan Area, the baseline years were 1994 and 1995. After adjusting for most of the meteorological variation, the improvement in the average ozone from the baseline years to 1996 was 14 percent.

The results for the San Francisco Bay Area are less dramatic than the results for the South Coast and Sacramento. After adjusting for meteorology, the analysis indicates that Bay Area ozone concentrations improved overall by 4 percent.

How much of the ozone improvement is attributable to cleaner-bUTjing gasolines The process by which ozone is formed in the lower atmosphere is complex, and various methods might be used to estimate the portion of air quality improvements that are due to c'eaner-burnang gasoline. For this analysis, we used the ratio of the emission reductions from cleaner-buming gasoline to the total emission reductions to apportion the overall ozone improvement to cleanerSurning gasoline.

Table 5 shows esrussion inventory data for the South Coast, Sacramento County (approximation for the Sacramento Metropolitan Area), and the San Francisco Bay Area. In each region, the total emissions of ozone precursors ROG and NO_X were reduced substantially between the baseline years and 1996. In all three regions, cleaner-burning gasoline accounted for more than half of the total reductions in ROG and NO_X.

For the South Coast Air Basin, the reduction in ozone due to cleaner-burning gasoline was approximately 11 percent (60 percent x 18 percent). Similarly, for the Sacramento Metropolitan Area, cleaner-burning gasoline achieved a reduction of approximately 12 percent (85 percent x 14 percent). For the San Francisco Bay Area, an improvement of approximately 2 percent (63 percent x 4 percent) in ozone is attributable to cleaner-burning gasoline.

How do these results compare with other analyses?

In late summer of 1996, the staff looked at preliminary data for June, July, and August. That initial analysis showed overall reductions in ozone of is percent, 11 percent and 10 percent in the South Coast, Sacramento, and Bay Area regions, respectively, after adjusting for meteorological differences between 1996 and the baseline years. Differences between that preliminary analysis and the more complete analysis discussed in this paper include the following:

erroneous surface temperature data included in the preliminary analysis for the Bay Area were removed for the more complete analysis, additional data for ozone and meteorology were used in order to complete the full ozone season of May through October, data for 1993 were added when preparing the equations relating ozone and meteorology in the South Coast and the San Francisco Bay Area, daily maximum surface temperature data were added to the Sacramento analysis, additional data for surface tempertures and wind speeds were added to the San Francisco Bay Area analysis, overall ozone improvements were calculated with respect to an additional set of baseline years—1993/1994—for the South Coast Air Basin, an estimate of the portion of ozone improvement due to cleaner-burning gasoline was added.

Of the above differences between this analysis and the preliminary analysis, the most significant was the removal of erroneous surface temperature data that had been included in the analysis for the Bay Area; the erroneous data had caused the preliminary analysis to estimate a substantially higher overall ozone improvement in the Bay Area compared with the improvement indicated by the new analysis (10 percent versus 4 percent).

The results of the new, more complete analysis show overall reductions in ozone (from the base years to 1996) for the South Coast and Sacramento regions (after adjusting for meteorology) that are similar to those in the preliminary analysis 18 percent versus 18 percent In the South Coast and 14 percent versus 11 percent in the Sacramento Area. The results for the San Francisco Bay Area are now less dramatic, showing a few percent reduction in ozone after adjusting for meteorology.

Another perspective is to loolc at what reductions in ozone precursor emissions are expected from the emission inventory. Table 5 shows emissions for the three regions and the reductions that were expected between the base years and 1996. The

reductions in overall ROG and NO_X emissions are 10 to 11 percent. The proportion due to cleaner-burning gasoline varies from to 9 percent. Ozone benefits, based on a one-to-one correspondence with the inventory data would suggest lower benefits for the South Coast and the Sacramento Area and higher benefits for the San Francisco Bay Area than those based on the analysis of ambient ozone data. The future may provide additional information to help reconcile these differing estimates of the impact of cleaner-burning gasoline on ozone concentrations in California.

The analysis described in this paper is not definitive, and conclusions based on it have some uncertainty. Nevertheless, this analysis offers strong evidence that cleaner-burning gasoline had a positive effect on ozone concentrations that helps validate its expected air quality benefits.

ATTACHMENT III

MTBE Compatibility with Underground Storage Tank Systems

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Findings

- Report is an initial compilation of MTBE compatibility knowledge obtained from published scientific studies, and from discussions with numerous UST experts. Much has been done to reduce and minimize releases of gasoline from underground storage tanks.
- In California, even though MTBE use has increased in recent years (especially since June 1996 when reformulated, MTBE-enhanced gasoline was implemented year-round across the State), there has been a steady decline in the number of new UST releases reported.
- Several tests found MTBE-blended gasoline did not impact steel tanks, steel piping or other metal components in gasoline distribution systems. Of the common gasoline additives, MTBE was found to be the least aggressive to steel and other metals. One study indicated that MTBE in gasoline increased the weight loss from 10–20 steel.
- All information indicates that MTBE is compatible with underground storage tanks and piping made from fiberglass.
- All available testing of numerous seals indicated they were compatible with the maximum MTBE concentrations allowed by law in gasoline [i.e. 15 percent MTBE volume/volume). However, additional investigation would be beneficial.
- No scientific basis could be found to support claims that MTBE may be causing UST teaks due to incompatibility with gives used in fiberglass UST systems, or due to incompatibility with vapor recovery systems.
- This initial data compilation did not discover any known. or suspected MTBE incompatibility issues with UST systems. However, additional investigations of these compatibility issues and more research on select topics (en: seal compatibility and vapor phase MTBE losses, would improve the knowledge base.

MTBE COMPATIBILITY WITH UNDERGROUND STORAGE TANK SYSTEMS

The purpose of this report is to review the available knowledge regarding the compatibility of the gasoline additive methyl tertiary butyl ether (MTBE) with underground Storage tank (UST) systems. This report is an initial compilation of MTBE compatibility knowledge obtained from published scientific studies and from discussions with numerous UST experts.

Background

Underaround Storage Tank Systems

Underground storage tanks (USTs) are commonly used to store petroleum fuels like gasoline. While there were about 2 million USTs in 1986, there are about 1.1 million in 1997. A gasoline UST system is typically comprised of an underground tank, product and vapor recovery piping systems, a fuel pump, and fuel dispensers with hoses and nozzles. UST systems can also be equipped with a variety of spill protection and leak detection devices including. automatic tank gauges, line leak detectors, spill boxes, and overfill protection.

At numerous points in a UST system, the fuel dispensing components are connected to one another. Steel tanks and pipes are typically attached by threaded con-

nections while fiberglass tanks and pipes are usually bonded (i.e. glued) together. Seals made of various materials are used throughout the fuel dispensing systems. Most materials and components used in UST systems are evaluated and listed prior to use by Underwriters Laboratories (a prominent materials testing laboratory).

MTBE Use and Subsurface Occurrence

Methyl tertiary butyl ether (MTBE) was first used commercially in the USA as a gasoline additive in 1979. Its use increased gradually through the 1980's as an octane enhancer (typically 1–8 percent volume/volume). Its usage increased more quickly in the 1990's as higher levels of MTBE were added to gasoline (11–15 percent vol/vol) to increase oxygen levels (as per regulatory requirements), and thereby reduce air pollution. If a UST or pipeline has an accidental release of gasoline, and that gasoline contains MTBE, then MTBE will escape into the subsurface along with many other gasoline components. Several published references provide a thorough summary of subsurface MTBE contamination issues (Davidson. 1995; Squillace et al., 1995).

MTBE COMPATIBILITY WITH UNDERGROUND STORAGE TANK SYSTEMS

When considering how gasoline can be accidentally released from USTs and pipelines, one factor to consider is how compatible [1] the gasoline and gasoline additives are with the tank and piping systems. Concern over MTBE releases to the subsurface has raised questions specifically about MTBE compatibility with UST system components. Detailed below are answers to some common questions about MTBE compatibility with UST components. In general, as summarized in a report by API (1990). "Ethers (like MTBE) are generally compatible with the same materials as straight gasoline".

ANSWERS TO SOME COMMON COMPATIBILITY QUESTIONS

What has Been Done to Reduce Product Releases From Uses?

UST systems have been substantially improved over the last 20 years through a variety of technology improvements including:

- fiberglass materials
- cathodic protection
- coated tank and line materials
- double wailed tanks and lines
- automatic tank gauging
- improved inventory control
- spill boxes
- overfill protection
- leak detectors
- dispenser drip pans
- interstitial monitoring
- improved integrity testing

In addition, nearly half the tanks that existed nationwide in 1986 have been removed. Many other tanks have been upgraded or replaced with more modern tanks. These improvements have worked together to reduce the number, duration, and the size of releases. This is demonstrated by UST release data compiled the State of California's State Water Resources Control Board (SWRCB). In California, the number of new UST leak incidents has declined steadily since 1988 when the Federal UST regulations became effective. California had over 4,000 new reports of releases in 1988, while there were approximately 1,000 in 1996 (the last year with complete data) (SWRCB, 1997).

As discussed above, substantial improvements have been made to UST systems for preventing and detecting fuel releases. However, gasoline releases can never be completely prevented because the operation of UST systems involves mechanical devices and potential human error. Some subsurface releases of gasoline will inevitably occur in spite of extensive efforts to prevent, minimize, detect and mitigate those releases.

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[1] Compatibility is the ability of a material to retain its physical properties when exposed to another substances (IC-Incorporated, 1997). With regards to underground storage tanks, if a stored liquid impacts, degrades, or corrodes the tank (or pipe) material, then that liquid is considered aggressive to that material, and would be considered incompatible with that tank material.

How Does MTBE Get into the Subsurface?

MTBE typically migrates to the subsurface as part of a release for releases) of MTBE-blended gasoline. This MTBE-blended gasoline may reach the subsurface due to:

- a spin of MTBE-blended gasoline that occurred prior to the upgrading of the UST system to meet the 1998 UST compliance standards.
- a spill of MTBE-blended gasoline that occurred after the upgrading of the UST system (even though the UST may meet 1998 compliance standards gasoline leaks may still occur due to human error ot mechanical failures}
- minor spillage of MTBE-blended gasoline (ex: spillage from vehicle drive-offs, consumers overfilling cars, overfilled spill boxes during delivery, nozzle drips, etc)
- a non-UST point source {ex: pipelines, surface spill of gasoline, etc.}
- a non-point source (ex:, storm water runoff, motorized vehicle use in surface water bodies, etc.)

It is important to note that no UST cases are known where only MTBE has escaped from the UST and impacted the environment. Such a scenario might suggest preferential loss of MTBE, but no such case has been reported. Instead, environmental scientists are typically finding MTBE along with all the other gasoline components, indicating a release of MTBE-blended gasoline.

Is MTBE Compatible with Metal Tanks and Piping?

Tanks can be made of bare carbon steel, coated steel, cathodically protected steel, fiberglass reinforced plastic (commonly called fiberglass), concrete, or composite materials like steel with fiberglass coatings (Schwendeman and Wilcox, 19871. Produc. piping used in underground storage systems is typically made of galvanized steel, cathodically protected steel, or fiberglass (Schwendeman and Wilcox, 1987). On rare occasions, other metals such as copper have been used for product piping.

Concern has been raised regarding the potential that the extra oxygen present in MTBE may enhance the oxidation and corrosion of metals (Sun, 1988). Therefore, seven gasoline blends (some with MTBE up to 15 percent, some with no MTBE) were used in immersion tests of metallic coupons (i.e. pieces) (Sun, 1988). These immersion test were conducted with equilibrated tank bottom waters present. Nine different metals commonly used in automotive fuel systems and gasoline distribution systems were tested. During hese six to seven month long tests, the metal coupons showed small weight chances in all the fuels. Weight loss (i.e. corrosion) or the 10/20 steel coupons over 6 months of immersion increased from a 2.95 percent weight loss to a 10.75 percent weight loss when MTBE was added to a base gasoline (Sun, 1988).

Lang and Palmer (1989) reported on a compatibility study that used standard reference gasolines combined with four possible gasoline additives: methanol, ethanol. tert butyl alcohol (TBA} and MTBE. Through a variety of immersion tests, gasoline mixtures of ail these additives were tested for tendency to corrode metals commonly used in automobiles, including brass, aluminum, zinc and mild steel. It was found that MTBE was the least aggressive of the additives tested.

Another report considered oxygenate compatibility with the materials used at vapor recovery units (VRU) at petroleum bulk plants (API, 1990). That study reported plain carbon steel and stainless steel are compatible with oxygenate vapors. The report also concluded that MTBE was the least aggressive additive to these metals (API, 1990).

Conclusion: Several tests found MTBE-blended gasoline did not impact steel tanks, steel piping or other metal components in gasoline distribution systems. Of the common gasoline additives, MTBE was found to be the least aggressive to steel and other metals. However, one study indicated that MTBE in gasoline increased the weight loss from 10/20 steel.

Is MTBE Compatible with Fiberglass Tanks and Piping?

Many modern USTs and product pipes (including many double walled systems) are made from fiberglass (Underwriters laboratories, Inc., 11383). A March 1988 report ISun, 1988) describes fiberglass compatibility testing performed on six test fuels (two base gasolines with no MTBE and four fuel blends with MTBE at 7.5 to to 15 percent). A sample fiberglass tank was tested by immersing a coupon of Xerxes fiberglass tank material in the six test fuels for 7 months at 68–70—F. Essentially no volume changes were measured for any of the fiberglass tank coupons. The volumetric swell range far the coupons immersed in the four MTBE gasolines was very small (from +0.26 percent [swelling] to -0.74 [shrinkage] (Sun, 1988). These volumetric changes are much less than most other components and materials tested (Sun, 1988).

Similar immersion testing was done on Ciba-Gieigy Fiberglass piping for 7 months (Sun, 1988). from these piping samples the volumetric change for piping sections in MTBE-blended gasolines ranged from +2.26 percent [swelling] to -1.32 percent [shrinkage] (Sun, 1988). Again, these volumetric changes are much less than most other components and materials tested (Sun, 1988).

There have been two major fiberglass UST manufacturers: Fluid Containment Formerly Owens Corning) and Xerxes. In a letter to their customers, 0wens-Corning/Fluid Containment said they had extensively tested fuels containing up to 20 percent MTBE, and there was very little effect on the laminate (Owens-Corning, 1995); Therefore, storage of these ether blends would not void the manufacturers warranty for USTs made since 1964. Thus, Fluid Containment has warrantied their tanks against internal corrosion for thirty (30) years for the storage of up to 20 percent MTBE for any of their tanks made since 1964.

Xerxes first listed MTBE-blended gasolines (up to 20 percent MTBE) on its April 2, 1988 warranty, where it warrantied their fiberglass tanks for 30 years. Prior to April 2. 1988. MTBE was not mentioned in the Xerxes warranty, although other, more aggressive, alcohols were previously addressed and covered by warranty.

Based on conversations with numerous fiberglass manufacturing experts, extremely similar materials and resins were used prior to 1988 as are used today to make fiberglass tanks and pipes. Therefore, it is unlikely that MTBE compatibility problems existed for pre-1988 fiberglass tanks. However, no pre-1988 data on fiberglass comparibility testing could be found at the publication time of this report.

Ether additives used in gasoline were also found to be compatible with most fuel systems and vapor recovery units at bulk plants (API, 1990). This study (API, 199O) found MTBE was compatible with materials in gasoline transportation, storage and blending systems, except for some Viton elastomers (discussed in next sections.

One study Smith Fiberglass Products Inc., 1996) investigated gasoline rmeability through fiberglass pipe by utilizing standard permeability testing methods. This study showed essentially no liquid gasoline lass through the fiberglass piping after 31 days while using 90 percent gasoline and 1095 ethanol. This long-term test demonstrates the extremely low permeability of fiberglass piping to liquid gasoline components. MTBE-blended gasoline was not tested. However, because of its larger molecule size! MTElE in liquid gasoline would be less likely to permeate through material pores than should smaller molecular compounds like methanol or toluene {Curran, 1997).

While many product piping systems are made from fiberglass reinforced plastic, the use of flexible piping systems made from polyethylene has increased greatly in recent years (ICF Incorporated, 1997). Seven of the eight flexible piping manufacturers have tested and approved their piping systems far use with MTBE, including using flexible piping as the primary piping system (ICF Incorporated, 1997). The eighth manufacturer did not report whether or not MTBE had been tested yet (ICF Incorporated, 1997).

It should be noted that not all gasoline oxygenating additives are compatible with ail UST materials. Specifically, some stronger blends of methanol-enriched gasoline are not compatible with certain types of fiberglass tanks (Schwendeman and Wilcox. 1987). However, this issue was recognized in the early 198Os and several formulations of fiberglass tanks were made with resins resistant to alcohols. A comprehensive list of alcohol compatibility with other UST materials is available (API, 1990).

Conclusion: All information indicates that MTBE is compatible with fiberglass tanks and pipes.

How Compatible is MTBE with Seals and Gaskets?

When stored in Tanks or shipped via pipelines, pure (or neat) oxygenates can adversely affect some elastomeric materials like seals and gaskets {AIexander en al., 1994). Deterioration from exposure to pure oxygenates usually comes in the form of swelling and softening (API, 1990). A study of neat MTBE compatibility with six types of seals commonly used in product pipelines found that neat MTBE apparently did not affect three types of seal materials. While the neat MTBE did aggressively swell three grades of Viton seals, these data are not pertinent as USTs are not used to store neat MTBE.

When considering MTBE as a gasoline component. this same study used MTBE at 20 percent volume/volume (which is higher than commercial gasolines) for the irnmersian tests on the six seal materials. They found that 20 percent MTBE in gasoline did "not significantly swell any of the elastomeric seals tested" (Alexander et al., 1994). Of the three Viton formulations tested, one had a minor swelling reaction and the other two Viton formulations had no noted reaction to 20 percent MTBE in gasoline. In conclusion, all six seals were deemed appropriate for use when MTBE concentrations were less than 20 percent of the gasoline. This conclu-

sion is applicable to all MTBE-enhanced commercial gasolines encountered in UST systems.

Similarly, Lang and Palmer (1989) conducted immersion tests to determine fuel additive compatibility with five common commercial mixes of rubbers (elastomers) used in vehicle fuel systems. Using standard reference gasolines containing either methanol, ethanol, TBA or MTBE, it was determined that MTBE was the least aggressive additive towards rubbers.

A variety of plastic and elastomeric parts commonly used in automobiles and gasoline distribution systems were tested in seven-month long immersion tests (Sun, 1988). Fifteen materials and automotive components were immersed in six test fuels for 7 months at 68–70 F. Results showed that some materials had about the same swell in 15 percent MTBE gasoline as in non-MTBE gasoline, while other materials swelled less. Only Vlton seals had significantly more swell with MTBE {up to 7 percent), though the degree of swelling was not considered significant by the authors (Sun, 1988).

A detailed investigation of oxygenate compatibility with bulk plant VRUs showed that "in no specific instance could the use of oxygenated fuels be directly linked to failures of components or degraded performance" (API, 1990). The study reported that seals and gaskets made from fluorocarbons, fluorosilicones and Teflon were compatible with oxygenates. This study also mentioned potential adverse effects on some Viton seals. but it was noted that as of 1990, manufacturers were developing certain formulations of Viton which were compatible with oxygenates (API, 1990). A survey of bulk plant terminals in 1994 (API, 1994) showed that since the introduction of oxygenated fuels, some terminals had changed the types of elastomers and polymers used for seals, gaskets and hoses.

Sun (1988) tested the evaporative losses of six gasoline blends from several types of vehicle fuel line and gasoline dispenser hoses. The six month evaporative loss rests showed that "there were no large differences between the samples containing base fuel and samples with base fuels and 150 percent MTBE" (Sun, 1988).

No pre-1988 data on seal or gasket compatibility fessing could be found at the time of this report's publication. As a result, no conclusions can be reached regarding MTBE gasoline compatibility with pre-1988 seals or gaskets. However, based on conversations with industry experts, no compatibility problems have been noted or suspected. More investigation would be beneficial.

Conclusion: All available testing of numerous seals indicated they were compatible with he maximum MTBE concentrations allowed by law in gasoline (i.e 15 percent MTBE volume/volume}. However, additional investigation would be beneficial.

What About Claims Regarding MTBE Possibly Dissolving Glues Used with Fiberglass Systems?

While these stories are often repeated, neither a thorough literature search, nor discussions with knowledgeable UST experts could establish any cases where MTBE had dissolved gives. These glues are used to bond fiberglass components together, such as piping sections. No specific references related to MTBE compatibility with glues was found.

The only related information was found in two publications (API 1985i; API 1986) where it was noted that some alcohol-based pipe thread dopes were not recommended for use with methanol or ethanol if the pipe dope had been recently applied. This may be the source of that incompatibility claim. However, this information only applies to alcohol additives, not to MTBE.

What About Claims that MTBE May Be Escaping the Vapor Recovery Systems or Secondary Containment Lines?

As discussed earlier, all studies indicate that MTBE in gasoline is compatible with fiberglass lines, including secondary containment piping and vapor recovery piping. No studies were found that addressed possible vapor-phase losses of gasoline or MTBE from UST fuel systems and/or vapor recovery systems.

A source far the claim regarding incompatibility with vapor recovery systems pining might be an unpublished paper by Mittermaier (1995). Tilis paper reported an incident in Wisconsin where MTBE reacted with a nylon coating on the inside of a vapor recovery hose. The resulting white powder quickly clogged the fine mesh screens in the vapor return line which made the recovery system ineffective. No gasoline release was reported from this incident. Apparently the cause was MTBE reacting with a nylon stabilizer used to protect the line from UV light and high temperatures (> 200 degrees F). Since this protection was not needed underground, the solution was to use nylon hose without this stabilizer. This may be the source of that incompatibility claim.

Vapor-phase MTBE entering the subsurface may be noteworthy. MTBE's high vapor pressure (roughly three times that of benzene) could cause the vapors in a UST system to be more enriched with MTSE than the liquid gasoline from which the vapors originally evaporated, As such, any gasoline vapors lor liquid gasoline condensate from those vaporsl that escape from a vapor recovery system could contain high percentages of MTBE.

CONCLUSIONS

This report is an initial compilation of MTBE compatibility knowledge obtained from published scientific studies, and from discussions with numerous UST experts.

Much has been done to reduce and minimize releases of gasoline from underground storage tanks.

In California, there has been a steady decline in the number of new UST releases reported since 1988.

Several tests found MTBE-blended gasoline did not impact steel tanks, steel piping or other metal components in gasoline distribution systems. Of the common gasoline additives, MTBE was found to be the least aggressive to steel and other metals. One study indicated that MTBE in gasoline increased the weight loss from 10/20 steel.

All information indicates that MTBE is compatible with underground storage tanks and piping made from fiberglass.

All available testing of numerous seals indicated they were compatible with the maximum MTBE concentrations allowed by law in gasoline {i.e. 15 percent MTBE volume/volume!. However, additional investigation would be beneficial.

No scientific basis could be found to support claims that MTBE may be causing UST leaks due to incompatibility with glues used in fiberglass UST systems, or due to incompatibility with vapor recovery systems.

* This initial data compilation did not discover any known, or suspected MTEE incompatibility issues with USA systems. However, additional investigations of these compatibility issues and more research on select topics (ex: seal compatibility and vapor-phase MTBE losses) would improve the knowledge base.

INFORMATION SOURCE

This document is based on the available literature listed in the References section, as well as upon extensive contact with UST design engineers and regulatory personnel. It was prepared by James Davidson, a hydrogeologist and the President of Alpine Environmental, Inc. (Fort Collins, CO). James Davidson has extensive experience investigating and remediating petroleum releases and has been involved with hundreds Of UST release projects across the USA and internationally since 1985. Also, Mr. Davidson has extensively researched and published on MTBE impacts to ground water and drinking water.

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ATTACHMENT IV

RFG IN FRP—FUELING THE FUTURE

FIBERGLASS TANK & PIPE INSTITUTE

This paper was written by Sullivan D. Curran, Executive Director of the Fiberglass Tank & Pipe Institute. The paper discusses the compatibility of gasolines gasoline-alcohol blends and 100 percent alcohol (e.g. methanol) with Fiberglass Reinforced Plastic ("FRP") storage tanks and piping systems manufactured by Cardinal Fiberglass Industries, Fluid Containment, Inc., Xerses Corporation, Ameron, Fiberglass Pipe Group and Smith Fiberglass Products Inc. The paper does not address other Few manufacturers or FRP products manufactured by others.

Reformulated gasoline ("RFG") has generated almost as much media attention about gasoline as the oil embargoes of the 1970's. Expected higher pump prices, possible shortages in some areas, logistics problems, concerns about additives and future changes to the formulation of RFG have made headlines. Now it's time to address the question of whether the current tanks, pipes and dispensing units in use at service stations all over the U.S. are adequate for the new fuel.

While debate continues among advocates of various alternative fuels, one constant remains: fiberglass tanks and pipe installations continue to provide a cost-effective and environmentally secure means to store RFG. However, storage is just one phase of the complete fuel refining and delivery system.

Why RFG, and why now?

Beginning January 1, 1995, the Clean Air Act required RFG in the eight areas of the country with the worst ozone pollution. States are permitted under the Act to "opt-in" additional ozone nonattainment areas into the RFG program, and 13 States have done so. As a result, RFG is expected to account for about 30 percent of the gasoline sold in the U.S. Conventional gasolines ("CG") sold after December 31, 1994, must also contain additives approved by the EPA.

The EPA recently ruled that a portion of the oxygen content of RFG—15 percent in 1995 and 30 percent thereafter—must be comprised of renewable oxygenates, such as ethanol.

Methyl Tertiary Butyl Ether ("MTBE"), Ethyl Tertiary Butyl Ether ("ETBE"), Tertiary Amly Methyl Ether ("TAME") are not renewable oxygenates. As issued, the renewable oxygenates rule would significantly increase the amount of ethanol blended with gasoline, but not above the current maximum blend rates of 10 percent by volume.

The American Petroleum Institute ("API") and the National Petroleum Refiners Association filed suit to halt implementation of the renewable oxygenates rule, and a Federal court issued a stay which prohibits EPA from enforcing the rule. Arguments on the suit have been presented.

If the renewable oxygenates rule is upheld by the court, refiners will have to move ethanol blending stocks to the terminals in separate shipments from conventional and reformulated gasoline. Because of its affinity for water, ethanol cannot be moved through the existing pipeline systems, but must be shipped on barges, in trucks or by rail. Complete pipeline dehydration would be required for multiple shipper-multiple product systems to avoid dissolved water contamination of other products such as aviation turbine fuels.

What is the Typical Composition of RFG

An average gallon of RFG, between 1995 and 1997, will have the following characteristics:

	Southern Areas	Northern Areas
RVP (psi)	7.2 Max. Summer	8.1 Max. Summer
Oxygen (percent wt.)	2.1 Min.	Same
(vol. percent)	5.8 percent Min. 10 percent Max	Same
Benzene (vol. percent)	1.0 Max	Same
Toxic (percent reduction)	15.0	Same

Concern about the effects of the alcohol-based fuels on equipment rubber and other elastomer components extends beyond the service station to refinery equipment, pipelines, pumping stations, terminals, trucks and marine vessels carving the fuels.

Valves and pump seals made of elastomers comprise many facets of fuel storage and delivery systems.

Whether these components, tank linings and membranes (e. g., tank jackets) will be able to stand up to the higher corrosive nature of the fixture fuels has yet to be experienced.

The API Recommended Practice 1626, "Storing and Handling Ethanol and Gasoline-Ethanol Blends at Distribution Terminals and Service Stations," addresses some of these issues.

API states that most materials used for storing, blending and transporting gasoline are also suitable for use with ethanol and ethanol blends. "However. engineering judgment is required when selecting materials for use with ethanol and ethanol blends to ensure the safety of facilities that handle these liquids," the document states.

API recommends inspecting the system and making modifications as needed, and checking all materials within the system for suitability for use with the ethanol fuels and replacing unsuitable materials as required.

Gasohols and FRP

Fiberglass reinforced plastic tanks and piping have been tested for fuel compatibility since before 1965, and testing has continued to meet the dynamics of the changing composition of fuels for these past 30 years. For underground storage tank and piping systems manufactured since gasohol came into the market, manufacturers have recommended the use of fiberglass tanks and piping for the maximum legal alcohol blend limits, i.e. 10 percent ethanol, 5 percent methanol or 15 percent MTBE.

Since 1978, waivers from ethanol or methanol legal blend limits have been requested by fuel and additive manufacturers in petitions to the EPA, i. e. under Section 211(f) of the Clean Air Act. However, to date the EPA has not Wanted waivers that would exceed the maximum alcohol blend limits. Further, to date EPA has not granted a waiver for any blend of a listed hazardous substance., such as methanol, to be stored or handled as a "gasoline." As a result, methanol blends above 5 percent must be stored in secondarily contained (e.g., DW or Double Wall) tanks and piping.

In 1983, Underwriters Laboratories, Inc. ("UL") updated their material compatibility testing protocol to recognize gasohol fuels in the marketplace. In addition, certain manufacturers of DW fiberglass tanks, primary piping and containment systems UL List products for alcohol-based filers and 100 percent ethanol or methanol. No comparable standard exists for steel or lined steel tanks or piping.

MTBE and FRP

While alcohols and alcohol blends have been used as fuels in the marketplace since the late 1970's, RFG is a new motor fuel beginning with its introduction on January 1, 1995. As shown previously, the legal limit for its major additive, MTBE is 15 percent. However, MTBE is not a new gasoline additive. Under EPA rules concerning allowable limits for oxygenates in unleaded gasoline, large gasoline refiners were granted MTBE waivers as early as 1979. Since that time and well before the introduction of RFG, MTBE has been stored and dispensed at the 15 percent levels in FRP tanks and piping throughout the United States.

—The introduction of MTBE, ETBE and TAME has not been of concern to FRP tanks and piping systems manufacturers who recommend their products for the legal limits of alcohol blends. Alcohols are hydrocarbon compounds that contain smaller hydrocarbon molecules than those found in MTBE, ETBE or TAME. As a result, ether-based gasoline additives are held to be less aggressive than their alcohol counterparts . . . thus, they will be readily contained.

RFG at the Service Station

Putting politics aside, consider the reality of RFG. The storage tank and piping systems are just one component of the fuel dispensing system at a service station. Each storage tank may have its own pumping unit and system of pipes leading to dispensing units on the service islands. These dispensers may have their own pumping unit and have meters, hoses and nozzles. These systems are often equipped with a vapor recovery system to prevent gasoline fumes from escaping into the atmosphere.

As the fuel compositions change to include more methanol, ethanol or other oxygenates, how will critical fuel delivery systems be affected, and which puts of the system are most sensitive?

Current retail dispensing equipment is designed to handle a maximum gasohol blend of 10 percent ethanol or 5 percent methanol. (By the way, automobile manufacturers generally state that their products are capable of handling up to 10 percent ethanol blends.)

Fuel system components must not craze, leak, or become permeable to fuel. They must retain flexibility, strength, and optimum hardness to provide required sealing. Service station operators should begin routine checks of the fuel delivery system and be alert to wear or corrosion in the following areas:

—Packing and seals on the pumps and meters

—Hoses, O-rings and other sensitive components in the nozzles

—Filters may need to be installed in the final dispensing system to ensure delivery of clean product. Meters may need to be replaced or recalibrated.

—API recommends consideration of the following dispensing system components when converting a retail service station to handle gasoline-alcohol blends:

—Meter replacement or recalibration

—Pumps and line leak detectors

—Dispensers and filters

—Alcohol-resistant materials—hoses, seals, nozzles

—Protection from water contamination—dryers on vent lines and pressure vacuum vents, fill cap O-rings

—Storage tank clearung and drying

—Storage tank and piping compatibility

—Application of special signs and decals

Conclusion

The increased oxygen content of RFG, and the possibility that even more oxygenates may be added to fuel in the future, require diligent efforts to ensure the safer of all components of existing fuel distribution systems. Thorough inspections should be conducted on a regular basis, manufacturers should be consulted as to the suitability of their products to handle the new fuels, and care must be taken to comply with known safety measures to protect equipment and distribution systems.

Owners and operators must also recognize the need to upgrade older systems to ensure the safe handling of oxygenated fuels.

As fuel compositions have changed over the years, fiberglass tank and piping manufacturers have continued testing their products to ensure compatibility with the new fuels. Rigorous compatibility testing and UL standards provide a high level of confidence that Fiberglass reinforced plastic systems will continue to be the preferred underground fuel storage and handling method despite chances in fuel composition.

ATTACHMENT VI

METHYL TERTIARY-ETHER (MTBE) IN WATER
DISCUSSION OF KEY ISSUES
STATEMENT PREPARED BY DR. MICHAEL C. KAVANAUGH, PH.D., PK., VICE PRESIDENT,
MALCOLM PIRNIE, INC.
DECEMBER 31, 1997

I have this statement at the request of the Oxygenated Fuels Association to address questions that have been raised regarding the fate, transport, and treatment of MTBE in water. At the recent hearings in Sacramento, California organized by Senator Barbara Boxer on issues related to MTBE use in California, several speakers raised concerns over the actual or potential impacts of MTBE on the quality of water in the State's major water supply sources. These concerns included the following:

- Aquatic toxicity of MTBE in the event of spills
- Persistence and possible accumulation of Mobil? in surface sources used for drinking water
- Significant current impacts on public water systems in California
- Possible wide-spread future impacts of MTBE on aquifers used as drinking water supplies in California
- Costs and efficiency of MTBE removal from water

The statements presented to Senator Boxer raise serious concerns regarding the safety of the drinking water supplies due to the use of MTBE in California, and were used by Senator Boxer to support a call for a phase out of MTBE in California. However a review of the facts regarding the current impacts and potential threat of MTBE to water supplies in California clearly show that the current concerns are exaggerated. These facts, which I have presented below, support instead a policy of continued monitoring, and a careful assessment of the risks and benefits of using oxygenates in gasoline, an assessment that will be carried out by the University of California over the next year.

Aquatic Toxicity of MTBE

Compared to many of the chemical constituents in gasoline, MTBE is considerably less toxic to aquatic organisms. For example, the concentration of benzene that will kill 50 percent of fathead minnows in fresh water (the LC-50) is 33 μg/L, compared to an LC-50 for MTBE of 980 μg/L. The concentrations of MTBE that are toxic to organisms in either fresh water or marine environments exceed the reported MTBE concentrations in lakes and rivers by factors of 5000 to 25,000. For example, the highest concentration of MTBE reported in California lakes has been about 50 ppb (.05 μg/L). The MTBE LC-50 for Rainbow trout is 1,237 μg/L. Thus, current releases of gasoline containing MTBE to surface waters in California pose a lower risk to aquatic organisms than other constituents in gasoline.

Persistence in Surface Waters

MTBE in pure form has a vapor pressure higher than other constituents in gasoline including benzene. When a gasoline spill containing MTBE occurs, MTBE will volatilize more quickly to the atmosphere compared to benzene and other constituents in gasoline. MTBE is more soluble in water than benzene, and has a lower Henry's constant, which indicates a slower rate of volatilization when the MTBE is dissolved in water.

MTBE has been detected in several lakes in California at levels up to about 50 ppb. The primary source of MTBE in these lakes is releases from recreational boating vehicles particularly those with two-stroke engines. In all lakes sampled in California, including Lake Tahoe, Donner Lake, Lake Perris, Lake Havisu, and San Pablo Reservoir, the concentrations of MTBE have decreased rapidly following cessation of recreational boating. Concentrations have generally decreased below 5 parts per billion (ppb) 20 to 40 days following the end of the boating season. Some critics of MTBE use have also reported that MTBE has been detected in Lake Merced in San Francisco where no recreational boating occurs. However, concentrations of MTBE have been below 1 ppb and are non-detectable in most samples.

These data indicate that in surface water bodies, MTB will likely volatize to the atmosphere in a relatively short period of time following cessation of the release of MTBE to the water body. This holds true for lakes, reservoirs, surface impoundments, rivers and creeks. Accumulation of MTBE in these surface water bodies is highly unlikely.

Current Impacts of MTBE on Drinking water Sources

The California Department of Health Services has required monitoring of public drinking water systems for MTBE since February 1997. As of December 1997, 33 drinking water sources have shown positive detections of MTBE. Nineteen of the samples are from groundwater sources, and 14 are from surface water sources. Approximately 25 percent of all water sources in the State have been sampled, and these sources supply water to over 70 percent of the State's population. Only four groundwater sources contained MTBE concentrations greater than 35 ppb which is the current State action level. Three of these samples came from the City of Santa Monica, and one from the City of Marysville. Recent sampling of the City of Marysville shows the MTBE levels in the impacted well have decreased below 2 ppb. Thus, the State survey shows that only one major public water system has been directly and adversely impacted by ROBE releases to the groundwater.

The City of South Lake Tahoe is also concerned about the potential impact of MTBE to their drinking water system and have shut down two wells because of fear of contamination. The only over major impact reported in California has occurred in the City of Glenville, where private wells have been contaminated due to releases of gasoline from a nearby underground storage tank. In all of these cases, the groundwater systems are highly vulnerable to groundwater contamination from surface sources due to shallow ground water extraction systems, or to known pathways of vertical migration of contaminants via abandoned water supply wells. However, these systems are not representative of public groundwater systems in California. Groundwater used for potable purposes in California is typically extracted from deeper aquifer zones, and the potential impact to these aquifers from releases of chemicals at the ground surface is for less than for shallow aquifer systems.

In summary, the most recent MTBE monitoring data from public water systems in California show that only one system has been directly impacted (City of Santa Monica). The potential for impacts on other groundwater systems exists, but the degree of vulnerability has not been established. Most aquifers in California draw water from deeper formations, which are generally less susceptible to contamination from releases of petroleum hydrocarbons, including MTBE and other oxygenates.

Magnitude of future threats of MTBE impact to Groundwater Systems

A significant concern raised by presenters at the Senator Boxer's hearing was the future threat of MTBE to drinking water sources. MTBE moves approximately at the same speed as groundwater and appears to degrade slowly, if at all, in the groundwater due to biological degradation. Recent evidence indicates that MTBE is likely to degrade in the subsurface. However, the rate is likely to be slow relative to degradation of benzene and other aromatic constituents in gasoline. While the presence of MTBE or other oxygenates in gasoline represents a continuing threat to water quality due to leaking underground fuel tanks, spills, and leaks from pipelines, the impacts on water quality are expected to be far less then has been suggested. MTBE is less dense than water and will not sink vertically through an aquifer. Vertical mixing of the MTBE to deeper aquifer zones is unlikely without significant vertical conduits such as improperly abandoned water supply wells.

A recent study completed by the Lawrence Livermore National Laboratory indicates that over 80 percent of the MTBE plumes emanating from leaking underground fuel tanks have not moved more than 300 feet from the original point of release. While these plumes may not be stable their rate of movement is slow in most cases, and the potential for plume stability once the plume has migrated past benzene, is high.

In summary, although some drinking water aquifers in California are clearly vulnerable to impacts from releases of gasoline at leaking ground storage tanks, the number of such basins a. significant risk is likely to be limited. An estimate of the magnitude of this threat is one of the points to be addressed by the current study being conducted by the University of California as required by the Mountjoy bill.

The future threat of MTBE is also likely to be less if it is shown that MTBE will degrade biologically in groundwater under appropriate geochemical conditions. Evidence is accumulating that MTBE does in fact degrade in groundwater, however, data consuming natural biodegradation in groundwater is limited and further studies are needed.

MTBE Treatment and Removal from Water

In contrast to concerns raised by critics of MTBE, existing water treatment technologies are capable of removing MTBE from water. For example, air stripping in a packed tower is capable of removing MTBE to levels acceptable for potable use. Capital and O&M costs for groundwater treatment depend significantly on the volume of water being treated and the removal requirements. Malcolm Pirnie has com-

pleted an assessment of these costs, and this analysis shows that for systems ranging in size from 600 to 6,000 gallons per minute, costs for air stripping range from 20 to 80 cents per 1,000 gallons of treated water, which is equivalent to approximately to $65 to $260 per acre-foot. This can be compared to the incremental cost for a new surface water supply in California which currently ranges from $400 to $800 per acre-foot and the costs for desalination plants which range firm $1,000 to $2,000 per acre-foot. Thus, treatment costs for removal of MTBE are significantly lower than the costs required for development of new water sources.

Other technologies are also available for removal of MTBE, including the use of advanced oxidation techniques. Costs of these technologies are highly site-specific, but they can be cost competitive with air stripping if off-gas treatment of the air stripper is required

Removal of MTBE from surface water sources is more problematic because of the type of treatment processes used. However, given the lack of persistence of MTBE in surface water sources the likelihood of significant impacts on surface water treatment plants is low.

Summary

In summary, a reviewer of the facts regarding the fate, transport, and treatment of MTBE in water shows that the threats to water quality in California's drinking water sources have been exaggerated. Although the threat to water quality is a legitimate concern, the Current monitoring data and on-going evaluations of the fate and transport of MTBE in the environment support a strategy of continued monitoring of drinking water sources and a careful review of the relative risks and benefits of MTBE and other oxygenates in gasoline compared to the use of other gasoline mixtures. Such studies are under way in California and should provide a rational basis for future management strategies to achieve both clean air and maintain clean water in the State.

ATTACHMENT VII

MTBE Concerns in California

In October 1997, the Tosco Corporation sent a letter to the California Air Resources Board (CARB) expressing their concerns over the extensive use of MTBE to blend reformulated gasolines in California (Newsletter #599, 11/6197). On December 1, 1997, the Chevron Corporation issued a press release expressing similar thoughts.

The Chevron press release appeals to Congress and California regulators to allow cleaner-burning gasolines to be manufactured in California without requiring oxygenates such as MTBE. The company has concluded that it may be possible to make a cleaner-burning gasoline without oxygenates, and still reduce emissions to the same extent achieved with current standards, which have been very effective in reducing vehicle emissions.

"We don't have all the answers yet," said Dave O'Reilly, President of Chevron Products Company, "but with regulatory flexibility, we believe solutions can be found. We're asking Congress to eliminate a mandate for oxygenates. We are also asking CARE to create the regulatory flexibility to allow oxygenate-free gasoline to be sold statewide."

Federal law mandates that oxygenates (2 wt percent oxygen) be in California's cleaner-burning gasoline in ozone non-attainment areas (Sacramento, San Joaquin Valley, Los Angeles and San Diego). Chevron supports legislation to remove that mandate and also urges the industry to work cooperatively with California regulators to explore options for reducing or eliminating MTBE altogether.

Both the Tosco letter to CARB and the Chevron press release express concerns over groundwater contamination. The Tosco letter states, "Our call to action is based on growing evidence of the potential for extensive MTBE contamination that could occur and the resulting liability to the State, and ultimately our citizens, could face to restore California drinking water supplies." In the Chevron press release, Mr. O'Reilly said "Chevron continues to assess its facilities and procedures for handling gasoline in order to reduce the possibility of spills. We are committed to preventing the release of gasoline—whether or not it contains oxygenates—into groundwater."

The fact that both the letter and press release allude to the potential contamination of groundwater demonstrates an industry concern over spillage and leaks of gasoline during transportation and storage. If these situations were corrected and prevented, there would be no potential for contamination of groundwater by oxygenates or the other, more toxic components found in gasoline.

In the Chevron press release, Mr. O'Reilly said, "While Chevron believes MTBE is not a public health threat and is safe if handled properly, the company recognizes the growing public concern. We want to supply Chevron's customers with products that meet or exceed all clean-air standards."

DeWitt & Company disagrees with the Chevron claim that Oxygenates in gasoline do little to reduce smog," MTBE, when added to gasoline, contributes not only oxygen, but a substantial octane boost with no olefins or aromatics added to the gasoline pool. There are no available, non-aromatic blend stocks which can approach MTBE's 110 octane. The reduction in both aromatics and olefins, coupled with MTBE's positive contribution to the Driveability Index are essential ingredients in the success of CARB gasoline. There is no reason to believe that the dean-air requirements of both Federal RFG and CARB gasolines can be met unless the overall oxygenate content is close to the present levels. Flexibility may permit successful, limited reductions in some cases, but cannot, we believe, lead to dramatic reductions in oxygenate use.

As the following table shows, the number of basin-days with ozone exceedances for the California South Coast Air Basin (Los Angeles area) has declined dramatically in recent years.

California South Coast Air Basin

Number of Basin-Days with Ozone Exceedance

Year	Federal Standard (0.120)	Health Advisory (0.150)	Stage 1 Episode (0.200)	Stage 2 Episode (0.350)
1988	178	144	77	1
1989	157	120	54	0
1990	130	107	41	0
1991	130	100	47	0
1992	143	109	41	0
1993	124	92	24	0
1994	118	96	23	0
1995	98	59	14	0
1996	83	50	7	0

*1996 data through September Source: California Air Resources Board

The steady decline in the number of ozone exceedances over the last 10 years can be attributed to many environmental improvements (i.e., lead phase-out, catalytic converters, more fuel efficient automobiles, reformulated gasolines, etc.). Certainly, the removal of older, less efficient automobiles from the active driving fleet has contributed to the air quality improvements in the South Coast Air Basin. We believe As do other authorities) that the significant reduction in ozone exceedances over the last 3 years can be attributed more to reformulated gasolines (Federal RFG in 1995 and CARB Phase II in 1996) than any of the other environmental improvements mentioned above.

According to a recent CARB publication, the South Coast Air Basin's maximum one-hour ozone concentration recorded is 0.24 ppm for 1996, a 59 percent improvement from 1965. The area exceeds Stage 1 Smog Alerts; (0.20 ppm ozone) on only 7 days for the entire year 1996. The is an improvement of 107 days, or a 94 percent reduction as compared to 1975. The implementation of CARB Phase II gasoline in 1996 reduces lung-damaging ozone and ozone precursors by 300 tons/day, as well as reducing airborne toxic chemicals like benzene that can cause cancer. This is equivalent to taking 3.5 million cars off the road (total registered vehicles in CA. exceeds 26 million).

Both the Tosco letter and the Chevron press release indicate that they support legislation to eliminate the Federal requirements (specifically the 2.0 who oxygen requirement for Federal RFG which must be supplied in the ozone non attainment areas) in the specifications for CARB Phase II gasoline. Rep. Brian Bilbray (R-CA) and Sen. Dianne Feinstein (D-CA) have introduced bills in their respective houses of the Federal legislature. These bills would give California flexibility to maintain its stringent fuel emissions standards without having to meet the Federal regulations requiring oxygenates in gasoline. 'It (the Senate bill) would only give this discretion to California, where MTBE has been found in some drinking water supplies, said Feinstein.

We feel sure that the main thrust behind the Tosco and Chevron proposals is the flexibility that would be created by the bills in Congress. It concerns us that the most apparent emphasis in their letter and press release are groundwater contami-

nation and limited improvement of smog conditions in California. Expression of these worries provides fodder for Oxy-Busters and some primary ethanol promoters. We cannot ignore the benefits that oxygenates have provided in reformulated gasolines. Air quality in California and other ozone non-attainment areas is very important. Gasoline in California that contains oxygenates (MTBE, TAME, ethanol, etc.) can be produced and distributed without harm to the environment. The banning of MTBE would surely result in the abandonment of the Clean Air Act improvements to date.

US Market Activity

Despite a significant drop in crude oil stocks (minus 5 million barrels), prices remain bearish. Crude oil futures prices have been under $19/barrel for more than a week. There has been limited price movement during this time and on Wednesday, crude reached an 18 month low closing price of $18.14/bbl. Gasoline prices have been bearish also despite a drop in inventories (-1.6 million barrels). The market (fuel oil) that you would expect an inventory drop this time of the year actually had an increase of 484,000 barrels. Refinery operating rates were down 94.8 percent. Spot market activity for MTBE in the US continues to be very quiet. Prices have softened considerably. A trade on Monday netted 79 cpg, FOB Houston. On Tuesday, a refiner sold to the trade at 77.75 cpg. Two trades in NYH this week were done on USGC postings plus 4 cpg. On Tuesday, another trade was done in NYH at a fixed price of 81.75 cpg for lifting 12/15–25. Bid-offers are currently at 80–81 cpg.

West Europe Market Activity

December Brent Crude price has fallen below $18 per barrel. Gasoline prices continue to decline as well. The price spread between regular and premium grades of gasoline has fallen to a slim margin of only $3/ton. This puts price pressure on octane blend stocks in this market.

The price ratio of spot MTBE to premium unleaded gasoline has fallen to less than 1.5. Refiners are looking for ratios of 1.35 or lower to incorporate MTBE in their blending operations.

Most of the trade is not interested in buying at current spot prices for movement to North America. They will opt to buy on the USGC at 77 cpg or less for shipment to the Northeast. It is reported, though, that one trader has purchased 12–15K tonnes for export based on price postings at the time of lifting. Therefore, he has quite a vested interest to see lower price postings.

Spot prices have fallen considerably this week. The market is reacting to the scenarios reported above. Nominal price has fallen from $280/ton last week to about $260–265/ton as of Wednesday. The ratio still leaves room for lower prices on MTBE.

Asia/Pacific Market Activity

It is reported that both of the Ibn Zahr plants in Saudi Arabia are having operations difficulties. It appears that both plants will experience some down time and that product shipments will be affected.

Gasoline prices have fallen considerably in Singapore during the past week Unleaded 92 RON has reached a low of 50 cpg. The octane value for MTBE has fallen with gasoline prices.

We report a drop in the nominal price for MTBE in Singapore to $265–270/ton.

F.W. "BILL" RUSSELL,
December 8, 1997

UNITED STATES SENATOR BARBARA BOXER,
California State Capitol hearing Room 4203,
C/O State Senator Richard Mountjoy.

DEAR SENATOR BOXER: It can be concluded from E.P.A., California Air Resource Board and U.S.G.S papers that M.T.B.E. was introduced before adequate health and water studies were started. completed or accepted.

Accumulating levels of M.T.B.E. constitute far greater long-term hazards to California's health, agriculture and water supplies than are warranted by the questionable gain of "cleaner air" through annually burning of millions of tons of this substance in gasoline.

I join with the Oil Companies, water suppliers of California and others, in urging that the Federal mandate for oxygenates be removed . . . and further urge, that the National water suppliers not be left with the inevitable cost of cleaning water that will attend on-going contamination or purchase of alternate supplies, as long as such may exist.

M.T.B.E. IN LAKE TAHOE

Finally, special funding is needed which will permit continuation of Lake Tahoe Water Studies THIS WINTER? Time is of essence in that M.T.B.E. has been detected to a depth of 100 feet at this National Treasure.

Winter tracking and determination of the affect of varying temperatures on the life and spread of this contaminant in Lake Tahoe is important and will have continuing value with reference lakes and reservoirs in general.

Inclusion of these remarks in the committee's study materials will be appreciated.

Very cordially yours,

F.W. RUSSELL.

IMPACT OF MTBE IN GASOLINE ON PUBLIC HEALTH IN PHILADELPHIA

BY PROFESSOR PETER M. JOSEPH, PH.D.
UNIVERSITY OF PENNSYLVANIA SCHOOL OF MEDICINE

1.0 Summary

MTBE is being added to gasoline because the Clean Air Act Amendments of 1990 require that an oxygenate chemical be used in Reformulated Gasoline. However, experience in Alaska and Montana in 1992 indicated that many people experienced adverse health effects from this additive. Previous scientific reviews of this question were flawed because they assumed that MTBE itself rather than some byproduct was causing the problems. I argue that existing data and experience imply that public health is being harmed by combustion byproducts of MTBE. Statistical health data from Philadelphia strongly support the association of huge increases in asthma, bronchitis, and other ailments with this gasoline additive. This data supports the complaints of thousands of citizens who believe that their health has been damaged by this gasoline additive.

Included Appendices

A. "Changes in Disease Rates in Philadelphia following the Introduction of Oxygenated Gasoline". Invited paper by Peter M. Joseph delivered to the annual meeting of the Air and Waste Management Association in Toronto, June, 1997.

B. Two graphs showing recently acquired data from the Hospital of the University of Pennsylvania; data on emergency room admissions for wheezing and hospital admissions for bronchitis.

C. Four letters (selected from several dozen) from people whose health has been diminished by MTBE in gasoline.

2.0 Purpose of MTBE

The addition of MTBE, like that of any oxygenate, to gasoline is intended to improve air quality by reducing the amount of toxic substances emitted in gasoline exhaust fumes. There are three categories of such fumes, namely: carbon monoxide (CO), oxides of nitrogen (NO_X), and other toxic chemicals. The effect of adding MTBE to gasoline has been extensively studied by an Auto/Oil industry group. Their results show that the effectiveness of adding MTBE depends drastically on the kind of car being used. All changes, both positive and negative, are less with modern cars which have extensive pollution control devices built in. The U.S. E.P.A. has also studied these effects. These results can be summarized as follows:

2.1 Effect on Carbon Monoxide (CO). Adding oxygen to gasoline does reduce CO. However, a thorough study of 150 cities by the EPA(1) showed reductions of CO to be less than 10 percent less than had been predicted. It must be emphasized that such a small reduction is of no medical consequence, even for people with serious cardio-vascular diseases. A similar study of CO in Denver found that using either MTBE or ethanol in oxygenated gasoline gave no detectable reduction in CO at all(2).

2.2 Effect on Ozone. This is complex because there are two distinct changes made in reformulated gasoline (RFG) that aim to decrease ozone. Ozone is created by the interaction of two different kinds of chemicals; reactive hydrocarbons and oxides of nitrogen (NO_X). First, the chemical composition of the gasoline is altered to include fewer of those especially reactive hydrocarbons that contribute to ozone. Second, when MTBE is added to gasoline, the effect is to increase NO_X, thus tending to worsen ozone. The A/OAQIRP final report(3) says:

> "Adding oxygenates to gasoline . . . in 1989 and earlier models . . . raised NO_X . . . The 1993 and later model vehicles did not show any emission changes. Neither the aromatic nor the MTBE content of gasoline had a significant effect on predicted ozone." (page 4).

In addition, the National Research Council report on Toxicological and Performance Aspects of Oxygenated Motor Vehicle Fuels (June 1996) says:

"The enleanment effect of Oxygenated fuels presents the potential for increased NO_X emissions from motor vehicles. Furthermore, much of the available data suggests that such an increase does occur. Any increase in NO_X would be detrimental in ozone nonattainment areas where exceedances have occurred during the period of the oxygenated fuels program". (page 50)

It is difficult to determine precisely the effect of gasoline changes on actual urban ozone levels. First, gasoline is definitely not the sole source of emissions that create ozone. The A/OAQIRP report #20 indicates (page 9) that approximately 80–90 percent of urban ozone is due to sources of pollution other than automobiles; the exact amount depends on the city. This percentage is projected as decreasing in the future, mainly due to improved pollution control technology in cars. The California Air Resources Board is claiming that RFG has reduced ozone by roughly 10–18 percent; however, this conclusion has been criticized because some of the reduction could be due to changing weather conditions((4)). My analysis of official air quality data in Philadelphia shows no evidence for any reduction in ozone at all (5); see Appendix A. An article in the August 26, 1997 issue of the Philadelphia Inquirer headlined "Northeast is enduring one of its smoggier summers in recent years" (6). These results from the east coast obviously support the tentative conclusions expressed in the National Research Council Report, and certainly contradict the grossly exaggerated claims of MTBE proponents that its use is dramatically "cleaning the air".

The most recent evaluation of the effect of MTBE on ozone is Report #21 of the A/OAQIRP, which specifically compares the effect on air quality of the existing California RFG with the same gasoline without MTBE. Graphs on pages 14,15, and 16 show increases in NO_X when MTBE is present, as expected. This effect is combined with the small reduction in reactive hydrocarbons in the exhaust, which tends to reduce ozone. The net result is a very slight decrease in ozone from using the MTBE-gasoline. This decrease, shown on page 25, is approximately 0.1 percent of the peak ozone, and is stated to be without statistical significance. It is utterly absurd to think that our current theoretical understanding of atmospheric and automotive chemistry is so precise that this minuscule effect is significant. It is certainly at least two orders of magnitude less than what could be significant medically, assuming it were true.

In conclusion, existing scientific data does not indicate that adding MTBE to gasoline will substantially reduce ozone, and there is considerable evidence to the contrary.

2.3 Effect on Air Toxics. It is often claimed that adding MTBE to gasoline reduces the emission of toxic combustion products. It is easy to see that such a statement is literally meaningless. Some air tonics, such as benzene, are decreased, while others, such as formaldehyde, are increased. Apparently what is meant is the total mass of the so-called air tonics, assuming all are equally toxic. The "toxicity" apparently takes into consideration only carcinogenesis, and not respiratory or neurological irritation. Furthermore, the statement applies to only a very limited list of four toxic chemicals. It is especially important that formic acid, which is considerably more irritating than formaldehyde or benzene, is not measured at all! Formic acid is expected to be a combustion product of MTBE. This statement is especially important in light of statistics showing a huge increase in respiratory disease in Philadelphia following the introduction of MTBE-RFG.

2.4 Effect on sulfuric acid. Scientists at the University of Utah(7) have discovered that when MTBE was used in winter oxygenated gasoline in Utah, the amount of sulfuric acid in the air doubled. This effect, which needs more study to be fully understood, implies that use of MTBE will increase acid rain and air pollution, especially when used in the vicinity of steel or power production plants. The acid thus produced will of course travel to other communities downwind.

3. History of Health Effects from MTBE

From the earliest application of MTBE in high quantities in gasoline people have complained of health effects. When MTBE was mandated at 15 percent in Alaska gasoline in 1992, hundreds of people in Fairbanks complained of various symptoms including, neurological (headache, nausea), respiratory (cough, stuffy nose) as well as eye irritation. The problem was investigated on an emergency basis by both the Alaska Department of Health and the CDC. Studies showed that people's symptoms were as great while riding on the highways as when pumping gasoline; this alone suggests that the problem is an exhaust product rather than from gasoline directly. Some say that these problems where psycho-social, rather than medical, and claim that there was "mass hysteria" invoked by publicity. However, there was no such publicity or mass hysteria in Anchorage, where the Department of Health found

symptom rates at least as large as in Fairbanks. Prompted by the complaints, the governor canceled the program in December of 1992. Follow up studies in February 1993 showed that the number of symptoms complaints dropped to almost zero. Direct measurements of MTBE in peoples's blood in December, and its absence in February, disprove the claim by some proponents of MTBE that MTBE was not removed from Fairbanks immediately.

A similar, if less dramatic, story unfolded simultaneously in Missoula, Montana, where again hundreds of citizens complained of the same symptoms as in Alaska. In addition, the local department of health surveyed local physicians, 66' of whom said that their asthmatic patients had gotten worse. Due to public pressure and public hearings, it was decided to use only ethanol in the next winter's oxygenated fuel season, and this greatly reduced the number of health complaints.

Similar public complaints emerged in January 1995 in Milwaukee, WI which resulted in the state Department of Health conducting a telephone survey. That study, which concluded that MTBE had no effect on public health, is in my opinion seriously flawed. First, they again assumed that any effects were due directly to gasoline rather than to an exhaust product. Also, the study was conducted after only two months of exposure to MTBE-RFG, which is not enough time to develop the full effects that I believe exist.

Similar public complaints have been registered in Colorado, Maine, Connecticut, New Jersey, Pennsylvania, Texas, and (most recently) in California. In most cases no serious effort has been made to investigate these complaints. In Maine, the Department of Health looked at statistics on hospital admissions for asthma, but only up to June 1995. That represents only six months of exposure to MTBE-RFG. My data in Philadelphia clearly show a progressive worsening of asthma and other diseases over a three year period.

In some cases individuals have written detailed descriptions of their problems, and why they believe they are related to MTBE in gasoline; see Appendix C. A key fact is that many of these people find that they become completely asymptomatic upon travel to areas without MTBE-RFG, or to non urban areas without air pollution problems. The EPA and other proponents of MTBE dismiss these complaints as "anecdotal". I would describe such testimony as "circumstantial" rather than "anecdotal". What these people are saying is that they become ill consistently under certain conditions, and better in other conditions, and that MTBE in gasoline is the important factor. In a few cases individuals (or entire families) have actually moved their place of residence soled to escape MTBE. (See Appendix C.) What is desperately needed is a research study to expose those people to exhaust fumes from actual automobile engines, comparing the effect of MTBE and non-MTBE gasoline.

4. Health Data from Philadelphia

In the past few years, there have been numerous reports of skyrocketing asthma rates in the Philadelphia region. Many school nurses and athletic coaches believe that they are seeing more now than ever before. However, collecting objective statistical data on this growth has not been easy, partly because many school administrators resist such data collection. Recent research shows that the school nurses know about only 1/3 to 1/10 of the asthmatic students in their school. Other problems are that the data is usually in the form of paper files in the offices of the school nurses, so tabulation of the numbers is a labor intensive activity and is beyond the duties of the nurses. Nevertheless, I have been given data on the historical growth of asthma in three schools, two in Pennsauken, NJ and one in Downingtown, PA. These data are included as graphs in the paper I presented to the annual meeting of the Air and Waste Management Association; this paper is included as Appendix A. These data show an astonishing Growth of asthma following the introduction of oxygenated Gasoline in November 1992.

The Philadelphia Department of Health believes that asthma has recently become a major public health problem in that city and has formed a group of experts called the Philadelphia Asthma Task Force. As a member of that task force, I have acquired statistical data on the office visits for asthma and other diseases since March, 1993. That data is shown in the AWMA paper in Appendix A. Note that not only asthma have increased, but also several other diseases including chronic sinusitis, and winter allergies. The number of visits classified as chronic bronchitis did not increase; I believe this may be due to bronchitis patients who go on to develop asthma and have their diagnosis changed. I know of some anecdotal reports of such changes.

Other data recently acquired is from the Hospital of the University of Pennsylvania. Graphs for the number of emergency room admissions for "wheezing" as well as for hospitalizations for chronic bronchitis for the period 1990 to 1996 are shown in Appendix B. Note the substantial increases that appear following the introduction

of oxygenated gasoline. The increase in wheezing is approximately 4-fold and the increase in bronchitis is approximately 10-fold! Furthermore, these increases appeared to start soon after oxygenated gasoline with MTBE was introduced. Keep in mind that my theory predicts that there the increases will not necessarily begin immediately upon usage of the MTBE, but there may be a delay of 1–2 years before large numbers of people develop sensitivity to the toxic byproducts of MTBE.

Besides this data presented here, I am working on collecting other data of a similar nature. I am not prepared to release this data at this time, either because more analysis is needed or because it is being developed in collaboration with other scientists. However, I can emphatically say that it supports the conclusions presented here, that in the period following the introduction of gasoline oxygenated with MTBE the Philadelphia area has experienced huge, unexplained, increases in asthma and certain other diseases.

5. Personal Testimonies

Literally thousands of citizens have observed that their health has diminished since MTBE was mandatory in gasoline, and have associated certain symptoms with its use. Some of these people, driven by desperation to bring the problem to the attention of governmental authorities, have written letters and statements of their personal experiences. A few of these are enclosed in Appendix C.

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97-TA34.02

For Presentation at the Air & Waste Management Association's 90th Annual Meeting & Exhibition, June 8–13, 1997, Toronto, Ontario, Canada

97-TA34.02 Please note addendum at the end of the paper

CHANGES IN DISEASE RATES IN PHILADELPHIA FOLLOWING THE INTRODUCTION OF OXYGENATED GASOLINE

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Introduction

Methyl Tertiary Butyl Ether (MTBE) has been used as an octane enhancer in the United States since it was approved in 1979. Statistics on its production(1) since 1981 show a remarkable rate of increase averaging 25 percent per year. It is by far the most rapidly growing chemical produced now in the U. S., with 1995 production estimated to be 17 billion pounds per year. Information on the exact concentration of MTBE used as an octane enhancer in gasoline is not easily obtainable, however, it seems that 3–5 percent is sufficient to raise the octane for most high-test grades of gasoline. Since 1992, it has been used in some regions as an oxygenate for the purpose of reducing pollution from automobile emissions. There were two government mandated programs that required oxygenated gasoline, the so-called winter oxygenated gasoline (WOO) and summer time reformulated gasoline (RFG). In regions with WOO it was required that all gasoline contain 2.7 percent oxygen by weight, and RFG requires 2.0 percent in most regions. This translates into 15 per-

cent and 11 percent MTBE by volume, respectively, and represents a enormous increase in the exposure of the public to MTBE and its exhaust products. There are no firm figures for this increase, but it can be estimated to be roughly 300 percent to 600 percent.

Because of its long history of use in the U. S., as well as its use in various foreign countries, some have concluded that MTBE must be safe for use in gasoline. I, however, suspect that an irritating byproduct, probably tertiary butyl formate (TBF), has been causing major public health problems in the past that have not been recognized. Asthma is increasing in many foreign countries. In the U.S. asthma mortality, which had been steadily declining prior to 1979, abruptly reversed direction in 1980 and has been climbing ever since.(2,3) See figure 1. No one has ever satisfactorily explained this reversal.(4) Clearly the question of adverse health effects from MTBE must be reexamined, with a focus on possible increases in disease in the general community, and not just in people occupationally exposed to gasoline fumes. This point was raised in a previous publication.(5)

Since 1992 there have been increasing public protests from citizens who believe that the use of MTBE in gasoline is harming their health. Protests have been documented in Alaska, Montana, Colorado, Wisconsin, Maine, Connecticut, New Jersey, Pennsylvania, Texas, and California. In New Jersey, a citizen's group called "Oxybusters" presented approximately 15,000 petition signatures to the governor in a public ceremony on July 13, 1995.(6) According to the petition, many of these people experience unpleasant symptoms while riding in cars, and attribute them to MTBE in the fuel. The issue is still controversial despite two reviews that concluded that adverse health effects are unlikely. In June 1996 the National Academy of Sciences released a report(7) analyzing the existing literature, and concluded that the data available do not rule out the possibility that adverse health effects exist.

It is possible that previous reviews of this problem(8) have arrived at incorrect conclusions because they misidentified the nature of the problem and therefore made several assumptions that are false.

The most important such assumption was that MTBE itself is the active toxin, rather than some atmospheric or automotive byproduct. For example, because studies in Alaska(9) indicated that people tended to have more symptoms while riding in cars than at gas stations, it was concluded that MTBE can not be the cause of the problem. This is because the concentrations of MTBE are far higher in gas stations than on roadways distant from gas stations.(10) However, if the active toxin is produced in automobile exhaust, such a pattern is exactly what one would expect. Furthermore, one would not expect to find a very strong correlation of symptoms with blood concentrations of MTBE, although such a correlation was found by a CDC study in Stamford, CT in 1993(11). This association was found among people occupationally exposed to gasoline, and could have come from MTBE itself or from some unsuspected contaminant in the gasoline.

It is important to note that some of the symptoms found in Alaska and Connecticut, namely, eye irritation, burning in the nose or throat, and cough, are typically produced by respiratory irritant chemicals. Such chemicals are widely acknowledged as inducers or exacerbators of asthma. Thus, the fact that asthma was not identified specifically as a concern in those preliminary studies does not imply that it is not affected by MTBE in gasoline.

A second assumption made in previous work was that the respiratory and irritant effects are short term. However, it is very well known that some chemicals, such as toluene di-isocyanate (TDI) can induce asthma in people exposed to very low concentrations (in the ppb range) over a period of several years.(12) This implies that the study of symptoms carried out by the Wisconsin Department of Health(10) in February and March 1995, comparing Milwaukee, Chicago, and rural Wisconsin was done too soon (two months after RFG) to pick up this effect. A similar criticism applies to the study done by Mohr et al.(13) of garage workers in New Jersey in 1993; that was done after only 7 months of exposure. Furthermore, the data of Mohr et al. do indicate a statistically significant increase in the symptom rate in the WOG region for symptoms experienced prior to arrival at work.

There are various other assumptions made by previous studies that could be challenged, but rejecting the two previous assumptions is sufficient to refute the argument that previous studies rule out any possible adverse effect of MTBE on community health.

Data

Because my own symptoms(5) were strongly correlated with the use of WOG and RFG, I have invested considerable energy in learning how many other people in the Philadelphia region have similar problems.

Based on casual conversation with strangers, I find that many have symptoms that I interpret as possibly attributable to some air toxin derived from MTBE.Since I do not know what this toxin is, I shall refer to it as the MTBE derived toxin (MDT). Many of these people report that they become asymptomatic upon travel to other regions in which WOG or RFG are not required.

There are widespread reports in the Philadelphia area of a dramatic increase in asthma over the last few years. This opinion is often found in school nurses and athletic coaches, and the situation has been reported in local newspapers(14). National statistics indicate that asthma prevalence, as of 1990, was about 5 percent nationwide.(4) However, since asthma is not a reportable disease there is no easy way to accurately establish the prevalence rate in any given area. In principle, the medical records of school nurses should provide an estimate at least for children of school age. For one school in Downingtown, Chester County, Pennsylvania, Mrs. Kathleen Brehm, the nurse for the Lionville School of approximately 500 students, was so concerned about what she perceived to be an alarming increase in asthma that she provided statistics from her office records from 1990 to 1996. Her classification of asthmatic children is based strictly on a physician's diagnosis as determined from a health questionnaire that she sends to each student's family in the fall of each year. These data, graphed in figure 2, show a remarkable increase of roughly 100 percent between October 1992 and October 1993. WOG was mandated in that area in November 1992 and again in November 1993. Mrs. Brehm reports that an unusually large number of 1995 sixth grade students had asthma, and the graduation of those students in June 1995 probably explains the decrease seen in 1996. The students in this school are predominantly of the Caucasian race.

An asthma survey form was sent to the principals of 50 elementary schools in southern New Jersey, focusing on communities close to the Delaware River and within the Philadelphia suburban region. The surveyed region did not include Camden, a city with a large minority population. Twenty of those forms were returned. Most of the returned forms stated the current number of asthmatic students known to the nurses, but gave no historical information. The nurses were asked to indicate whether, "over the last few years", they thought the asthma rate had increased, deceased, or stayed the same. Of those expressing an opinion, 12 indicated no change, 8 indicated an increase, and none indicated a decrease. The average prevalence rate for those schools in which the nurses perceived an increase was 6.8 percent, with three schools over 10 percent. The average prevalence rate for those schools where the nurses did not perceive an increase was 5.6 percent, with the largest being 8.8 percent. Only four schools provided data on the historical growth of asthma. Summing those results showed the number of identified asthmatics increased from 77 in 1992–93 to 98 in 1996–97. This represents an increase of 27 percent and is of marginal statistical significance.

However, Mrs. Meg Snyder, a school nurse in Pennsauken, NJ called to complain that her school had not been included in the sample. She said that her asthma case load has been growing "exponentially" and requested to be included. She and a colleague returned forms that indicated a very substantial growth in asthma cases, shown in figure 3. The average prevalence rate for the two schools in 1996 was 62/586=10.6 percent. Pennsauken has been described as a "blue collar" community and is very close to the Delaware river across from Philadelphia, adjacent to Camden.

The Philadelphia Department of Health operates eight public health clinics. These clinics have a computerized data base, including diagnoses, for each patient seen since March 1993. For each visit the physicians fill out a reporting sheet on which they are required to check at least one diagnosis box based on the common ICD-9 diagnostic coding system. The clinic operations are divided into adult and pediatric sections, with the latter accepting patients under the age of 18. There were no changes in the diagnosis reporting forms for adults since 1993. However, at the end of 1993 there was a change in the forms used for pediatric patients. Some of the diagnostic terminology changed in the new forms, so for this reason most of the pediatric data was rejected. However, the diagnostic category "asthma" did not change. For this reason, asthma data were taken for both the adult and pediatric populations, whereas only adult data were used for the other diagnoses studied. Data were obtained for the number of visits in which a diagnosis code included one of seven diseases thought to be influenced by possible irritation from MDT. The diagnoses of interest were asthma, chronic sinusitis, chronic bronchitis, allergic rhinitis, conjunctivitis, otitis, and "dyspnea". The latter condition is not a recognized disease but simply expresses the symptomatic problem of difficult breathing; "pure dyspnea" was defined as visits in which dyspnea was the only diagnosis box checked. Inflammatory conditions that were diagnosed as acute (such as acute rhinitis or acute sinusitis) were not included because they are most likely to have an infectious etiology.

These data are presented in table 1. Each year in that table is defined as starting in March and ending in February of the following year. In addition to the seven target diagnoses, also shown are the total number of visits as well as numbers for two diagnoses (hypertension and diabetes) that are not thought to be influenced by air pollution. The percentage increase numbers are calculated from the raw numbers of visits. With one exception, the increases seen have a high degree of statistical significance. Only chronic bronchitis did not significantly increase.

Prior to the collection of any of the data presented in this paper, in 1995 officials in the Philadelphia Department of Health perceived a growing asthma problem in the city. This lead to the establishment of the Philadelphia Asthma Task Force, a committee consisting of experts in medicine, pharmacy, nursing, environment, education. and data management, drawn from various institutions in the city and region. This Task Force meets monthly to discuss ways to gather data to analyze the situation? and is also planning various programs to improve delivery of medical services to asthmatics.

Further evidence of an alarming increase in asthma in Philadelphia comes from increases in the numbers of cats treated for asthma at the University of Pennsylvania. Dr. Jeffrey Wortman, Associate Dean at the University of Pennsylvania School of Veterinary Medicine, has provided statistics (figure 4) that show a dramatic increase in the number of visits for cats treated with asthma. The vertical error bars in the plot represent one standard deviation. A chi-squared analysis of the null hypothesis, that there is no increase, gave a value of chi-squared = 24.5 for 5 degrees of freedom; the corresponding $P < 0.001$, so the increase is highly significant statistically. The timing of the increase is consistent with the introduction of WOG in the fall of 1992. Dr. Wortman is attempting to collect similar data from other veterinary hospitals. Unfortunately, most such institutions are located in rural areas without the air quality problems from NIDT that are present in major cities such as Philadelphia.

Other Studies

In addition to my attempts to chart the growth of asthma, several other medical researchers are engaged in studies to determine the current prevalence of this disease.

Mangione et al. (15) have studied two different middle schools in Philadelphia, using a technique in which students are asked to fill out a symptom questionnaire after having seen a video tape presentation of the symptoms of asthma. Their results suggest a prevalence of at least 28.8 percent by the most rigorous criterion, namely, symptoms at least once per month. They also found that only 30 percent of the asthmatic students were registered as such with the school nurses. This suggests that asthma is underdiagnosed in these populations, which were predominately African-American or Hispanic. It also suggests that other surveys based on the school nurse records. such as mine may be greatly underestimating the severity of the current asthma problem.

The pulmonology group at Temple University Hospital, under Dr. Gilbert D'Alonzo,(16) are studying the prevalence and severity of exercise induced bronchospasm in high school athletes in several schools, both within the city of Philadelphia and in several suburban communities. They test students who are actively engaged in playing on the school's sports teams, so the population is undoubtedly biased toward the strongest and healthiest students. The volunteers run one mile, after which their pulmonary function is evaluated by measuring peak flow. The percentage of athletes showing significant reduction in pulmonary function in this test is again surprisingly high, reaching 24 percent for the African American students in Philadelphia and 12 percent for the Caucasian students in the suburbs. All of the suburban schools studied so far are within the five counties required to have either WOG or RFG, most of it with MTBE.

Dr. Andrew McBride, director of public health for the city of Stamford, CT has been conducting surveys of asthma prevalence in the schools in that city(17, 18). Preliminary analysis of the data collected in the fall of 1996 indicate that 15 percent of the kindergarten children have been diagnosed with asthma by their physicians, and another 9 percent appear to have symptoms of asthma but have not been so diagnosed. This again indicates a prevalence approaching 25 percent under current conditions. An earlier smaller study conducted in the 1992–93 school year indicated asthma prevalence rates of about 7–8 percent, which were considered to be unusually high at that time. Stamford is not far from New York City and has always been on the same schedule for gasoline oxygenation, with longer periods of WOO than Philadelphia during the first two years. It is noteworthy that the Stamford Advocate, in addition to covering the growth of asthma in that community, has also pub-

lished an article in which several residents complain of multiple experiences of chest pain or dyspnea while traveling on local highways.(19)

Other air quality factors

One should ask if there may be other air quality factors other than MDT that could explain the observed increases. In this regard, I have considered ozone.

Data from the Philadelphia Bureau of Air Quality Management give temperature and ozone concentrations measured in Philadelphia. This data was analyzed by computing the average of the maximal ozone concentrations for each day in July and August for the years 1993 through 1996. Only ozone maxima which occurred between 10 AM and 5 PM each day were included. Also computed were the averages of the daily maximal temperatures. The results are shown in figure 5, together with the line of linear regression. As expected, we see a clear correlation between the average summer temperatures and average ozone maxima. The standard error (S.E.) on the ozone values is approximately 3 ppb; the error bars shown are 1 S.E. The summer of 1995 was exceptionally hot in Philadelphia, while that of 1996 was exceptionally cool. This analysis does not show any evidence for any reduction in ozone during the RFG years (1995 and 1996) as compared with the previous years (1993 and 1994); however, a change of 5 percent in either direction can not be ruled out. This lack of improvement is despite the well known long term downward trend in ozone, which is generally attributed to successful programs to reduce ozone, including better pollution control technology on automobiles. The decline in ozone is evident in the decrease in the number of exceedences of the ozone standard (120 ppb). Exceedence data obtained from the Pennsylvania Department of Environmental Protection are shown in figure 6. Note that some exceedences did occur during the summer of 1996, which was exceptionally cool, even though RFG was mandatory in the five county region.

Discussion

The data presented support the assertion that, since 1993, the Philadelphia area has experienced a significant increase in asthma and certain other diseases thought to be responsive to air pollution. With the exception of chronic bronchitis, all of the increases have a high degree of statistical significance. However, it is not possible to conclusively argue that these increases are due to gasoline oxygenated with MTBE. At the least, to justify such a conclusion it would be necessary to show comparable data from other nearby regions that were not included in the WOG or RFG programs. It would also be desirable to have data on disease rates extending back in time at least to 1990. To date I have not succeeded obtaining such data.

The lack of increase in chronic bronchitis (CB) may indicate that it is not responsive to the MDT in the air, or it may be a statistical artifact. For example, if significant numbers of CB patients went on to develop asthma during this three year period, their diagnoses may have been changed from bronchitis to asthma. The physicians making these diagnoses are mostly not specialists in pulmonary disease, and misdiagnosis of these two diseases is not uncommon outside of the hospital environment. CB is most commonly seen in smokers, and there is no reason to assume that the number of smokers in Philadelphia has changed significantly in recent years.

Similarly, it has been suggested that asthma may be overdiagnosed, and that many such diagnoses are incorrect. If that is true it is irrelevant for the purposes of this paper. What these data show is that there is an increase in what appears to be asthma based on the judgment of the clinic physicians. If the asthma diagnosis is incorrect is some cases, the data still show that respiratory diseases of some kind (perhaps unknown) are increasing.

The diagnosis "pure dyspnea" is especially interesting because it is not a recognized disease, but merely a statement that the patient has trouble breathing. One would expect that physicians would be reluctant to indicate that as the only diagnosis, since they would be admitting that the actual underlying disease is unknown. Based on interviews with several dozen people, I believe there may indeed be a condition due to MDT which leads to temporary trouble breathing. Several individuals I know of have gone to emergency rooms with this problem, only to be told that they do not have asthma, and with no other diagnosis suggested. In many cases, these attacks of dyspnea come while riding in cars(19). Such a pattern to the symptoms would be practically impossible to diagnose in a traditional clinical situation, which assumes that the patient's condition is the same while being examined in the clinic as it is while riding in the car!

There are some interesting features of the monthly variation in the office visit data, but in the interests of brevity these will be discussed in a later paper. One important point is that the increase in allergic rhinitis in winter could not be due to either pollen or ozone pollution.

The progressive nature of the increases seen could be interpreted to mean that it is due to some pollutant that is increasing slowly. However, I argue it is more likely due to the slow increase in the number of people who have developed sensitivity to the MDT. In other words, even in regions which have been using RFG with a constant volume fraction of MTBE, one would expect to see a slowly increasing prevalence of such sensitized individuals over a period of years. This is exactly the pattern that is known to exist for at least one other chemical irritant, TDI(12). This concept would suggest that eventually the number of sensitized individuals would level out, but the time constant for achieving this equilibrium is obviously unknown. I personally know of many individuals who have developed symptoms that have the MDT pattern after two or three years of exposure. It is also possible that as people age they become more likely to develop the sensitivity.

One lesson learned from this work is the unreliable nature of data collected from school nurses. Many school nurses see their job as responding to emergency situations, and not to chronicle the general health of the student body. Most nurses rely on data given to them voluntarily by the parents, and few take a pro-active approach and request medical information from the families on a regular basis. Mrs. Brehm of Downingtown was one of the few who actively demanded medical information from the parents of her charges. For this reason, I think that the increase that her data show from 1992 to 1993 is significant, because there were no changes in her polling techniques over that time, and presumably no changes in the diagnostic abilities of the community's physicians. The excellent work of Drs. Mangione, D'Alonzo, and McBride clearly show that asthma is often grossly underreported to the school nurses.

An important concept in my theory is that the MDT is produced primarily as a combustion product in the automobile engine, rather than from MTBE itself. TBF is a very likely candidate for the MDT because it can be produced by simple partial oxidation:

$$\text{MTBE} + O_2 \longrightarrow \text{TBF} + H_2O.$$

That is, one needs one atom of oxygen to oxidize the methyl moiety of the MTBE while leaving the t-butyl group unchanged. TBF is known to be the predominant product of atmospheric transformation of MTBE by hydroxyl radicals in the air(20,21). It is also the predominant byproduct of the use of ozone to treat water contaminated with MTBE.(22) This suggests that at least under ambient temperature conditions the t-butyl group is more resistant to oxidation than is the methyl group. It has been argued that two factors would work against the production of TBF in automotive combustion. One argument says that the temperatures in the internal combustion engine are so high that the t-butyl group would not survive. Another says that any TBF produced would beoxidized to water and CO_2 in the catalytic converter in the automobile's exhaust stream. Both of these arguments may be partially correct, but they can not be totally correct, since the existence of a very rich array of complex hydrocarbons, including MTBE, in the exhaust clearly shows that at least some complex molecules do in fact survive. The relatively cool layers of gas very near the surfaces of the engine's cylinders could provide the conditions in which partial oxidation would be expected to operate. Furthermore, it is known that some free radicals are produced in the combustion process, and it is exactly such radicals that are known to convert MTBE into TBF(21). In none of the exhaust speciation studies published to date has any attempt been made to identify TBF in the exhaust gases. The products listed include a few percent called "unidentified hydrocarbons".(23,24). In summary, there is no reason to doubt that TBF is being produced, and the main question is how much. Research on this question is urgently needed.

A well known example of the production of formate in automobile exhaust is the production of formic acid (FA) from methanol(25). This is closely analogous to the production of TBF from MTBE since both involve the partial oxidation of the methyl moiety. It is also possible that FA is produced from MTBE fuel. FA is known to be extremely irritating to the respiratory system. There may well be other byproducts of MTBE combustion that are functioning as the MDT. Examples that come to mind are t-butyl alcohol and t-butyl nitrite.

Among the possible combustion products of MTBE, TBF is a prime suspect because, as an ester of formic acid, it must be assumed to be extremely irritating to the respiratory system and could cause the increase in respiratory diagnoses reported here. The only toxicological information publicly available to date is the MSDS published by the Fluka Chemie Company of Buchs, Switzerland. The acute effects claimed in that document indicate that TBF is "extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin. Inhala-

tion may be fatal as a result of spasm, inflammation and edema of the larynx and bronchi, chemical pneumonitis and pulmonary edema. Symptoms of exposure may include burning sensation, coughing wheezing, laryngitis shortness of breath . . . ". Even if these dangers are exaggerated for legal purposes, one can not justify ignoring the warning they provide and the possibility of serious public health effects. Obviously, more serious research into the toxicology of TBF is needed.

It is possible that the putative effects of MTBE on public health are not due solely to MDT, but could be the result of synergistic interaction with other factors. For example, anything that tends to cause chronic mucosal inflammation in sensitive individuals may enhance the sensitivity to MDT. Such factors could be other irritating pollutants, or biological allergens such as dust or cockroaches. Further research on such synergistic interactions is needed.

While these data do not conclusively prove that MTBE in gasoline is harming public health, they raise the serious possibility that this is happening. In view of this, it would appear that all plans to expand the use of MTBE-RFG to other areas on the assumption that it will produce health benefits are seriously ill advised. An immediate moratorium on such expansions is urgently needed. Similar concerns would apply to other methyl ethers, such as tertiary amyl methyl ether (TAME), since they also can produce esters of formic acid by partial oxidation.

Conclusions

Data collected from various sources in the Philadelphia area indicate an increase in asthma and certain other diseases during the period from 1993 through 1995. The most statistically significant data came from computer records of public health clinics, and unfortunately those records begin only in 1993. It is argued that the most likely explanation for these increases is the generation of some unsuspected toxic substance produced by the combustion of MTBE in gasoline. The institution of the oxygenated gasoline program in the fall of 1992 means that the amount of such pollution greatly increased at that time. Three time-history sets of data support such a time association, including an abrupt increase in asthma prevalence in one suburban school, and a similar increase in the number of cats treated for asthma at a city veterinary hospital. In addition to the work reported here, results being obtained by researchers in Philadelphia and Stamford, Connecticut, also indicate extraordinary prevalence rates for asthma among urban children in those cities.

It is argued that the most likely explanation for the observed effects is the production of TBF from the combustion of MTBE. It is noted that asthma mortality began to rise in 1980 immediately after MTBE was approved for use in gasoline. It is argued that previous studies that rejected an association between MTBE in gasoline and health problems were flawed because of several false assumptions, in particular, that MTBE rather than some combustion product was responsible. Several avenues for future research on the problem are suggested.

Acknowledgments

Obviously, this paper consists primarily of data provided by other people, and I am indebted to many individuals for help. The Philadelphia Department of Health, especially Dr. Lawrence Robinson and Mr. Warner Tillack, provided the statistical data on clinic visits. The Philadelphia Bureau of Air Management, under Mr. Robert Ostrowski, provided air quality data. Dr. Jeffrey Wortman provided his data on asthma in cats, even though the project is not yet finished. Drs. Mangione and D'Alonzo provided abstracts of their work prior to their being accepted for publication. Dr. McBride sent me his asthma survey results. Barry Doryman and Linda Maietti provided help in the survey of the New Jersey schools. And of course, Kathleen Brehm, Meg Snyder, and other nurses gathered invaluable data on asthma from their past records, work that was certainly beyond the call of duty.

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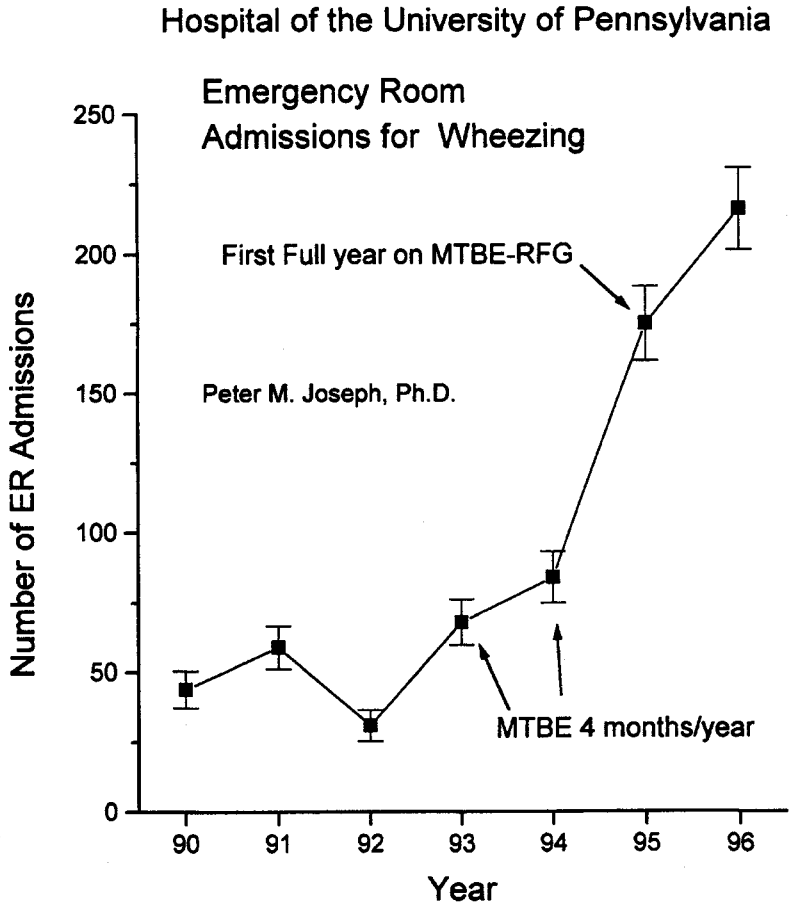
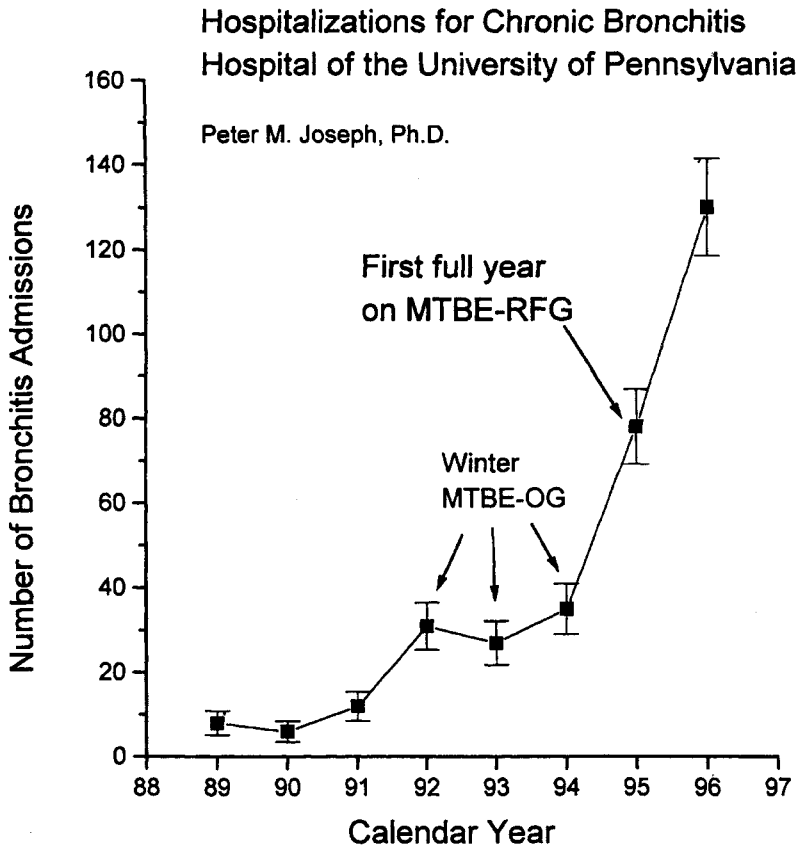

Hospital of the University of Pennsylvania
Emergency Room
Admissions for Wheezing
First Full year on MTBE-RFG
Peter M. Joseph, Ph.D.
MTBE 4 months/year
Number of ER Admissions
Year
250
200
150
100
50
0
90
91
92
93
94
95
96


Hospitalizations for Chronic Bronchitis
Hospital of the University of Pennsylvania
Peter M. Joseph, Ph.D.
First full year
on MTBE-RFG
Winter
MTBE-OG
Number of Bronchitis Admissions
Calendar Year
0
20
40
60
80
100
120
140
160
88
89
90
91
92
93
94
95
96
97

97-TA34.02

Table I. Numbers of office visits to public health clinics in Philadelhia for selected diseases from 1993 through 1995.

Diag./Year	1993	1994	1995	Increase
Part I. Diseases responsive to air pollution.				
AS	4848	6197	6972	44%
AR	1646	1861	2105	27%
WR	311	401	460	48%
CJ	362	434	606	67%
CB	480	439	515	7%
PD	35	46	81	131%
OT	754	846	980	40%
CS	699	949	1191	70%
Part II. Total number of visits and diseases not responsive to air pollution.				
AV	203,907	230,474	224,732	10%
HT	32,459	35,107	36,063	11%
DB	21,343	22,056	20,853	-2%

Abbreviations:

AR = Allergic Rhinitis, AS = Asthma, AV = All Visits,
CB = Chronic Bronchitis, CJ = Conjunctivitis
CS = Chronic Sinusitis, DB = Diabetes, HT = Hypertension
OT = Otitis, PD = "Pure Dyspnea" (see text),
WR = Winter Rhinitis

Each year is defined as starting on March 1 going through the next February.

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Figure 1
Asthma Mortality in the U.S.

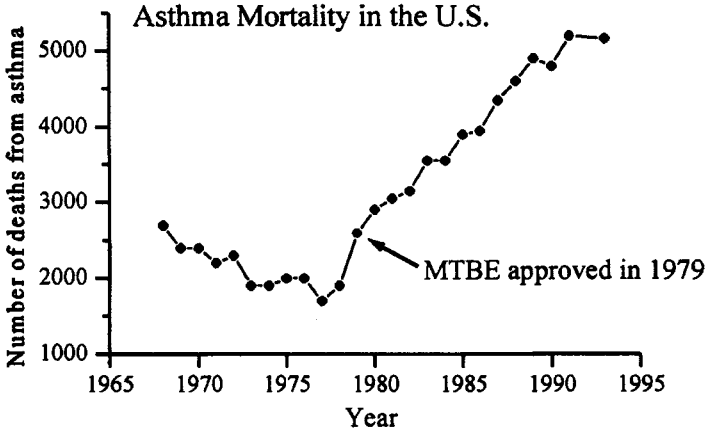

Figure 2
Percentage of Asthmatic Students in
Lionville School, Downingtown, PA

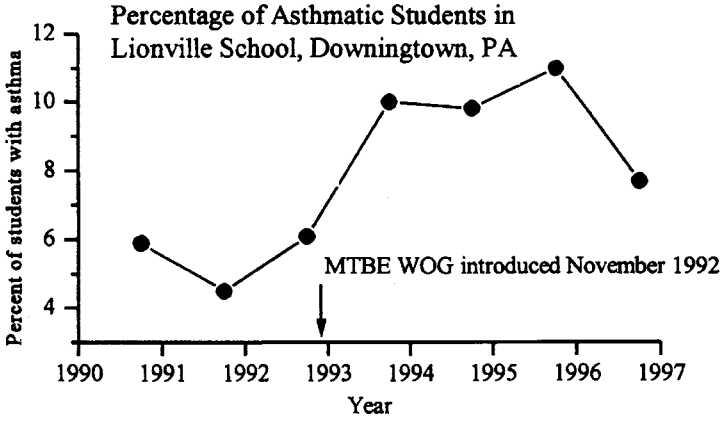

Figure 3

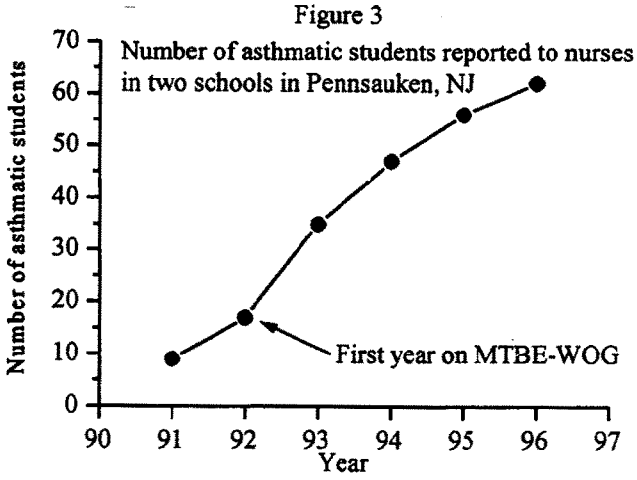

Figure 4. Feline asthma: U. of PA VHUP

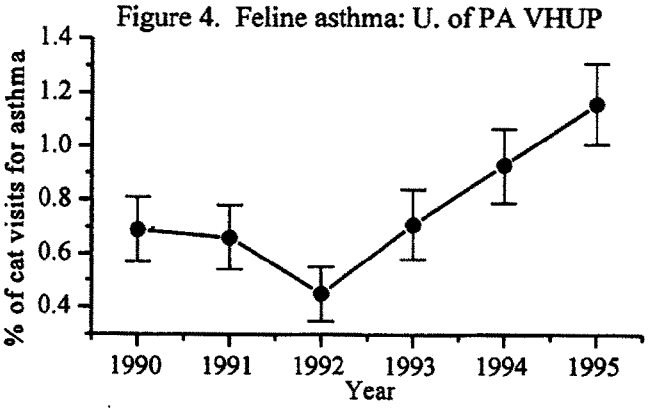

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Figure 5: Average Summer Ozone vs. Temperature

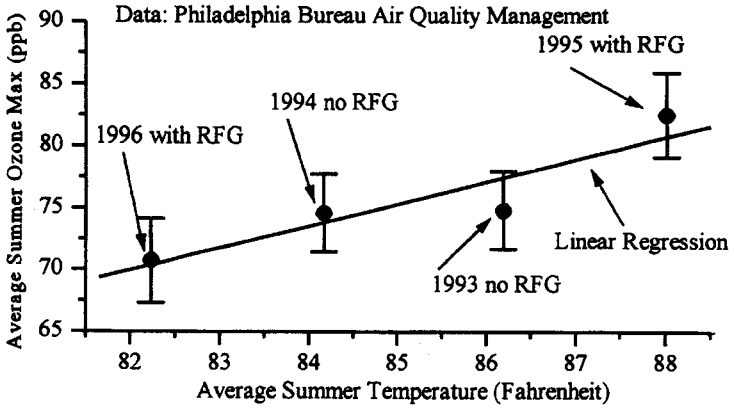


Figure 6

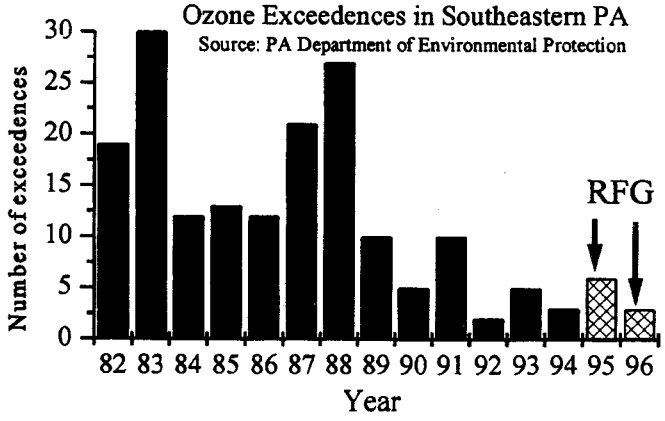


Figure 5: Average Summer Ozone vs. Temperature

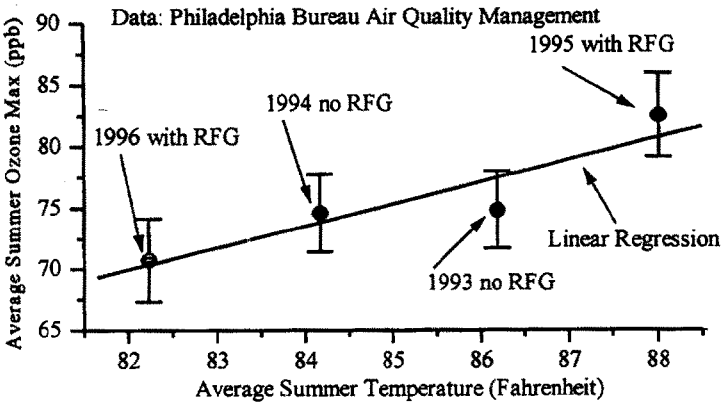
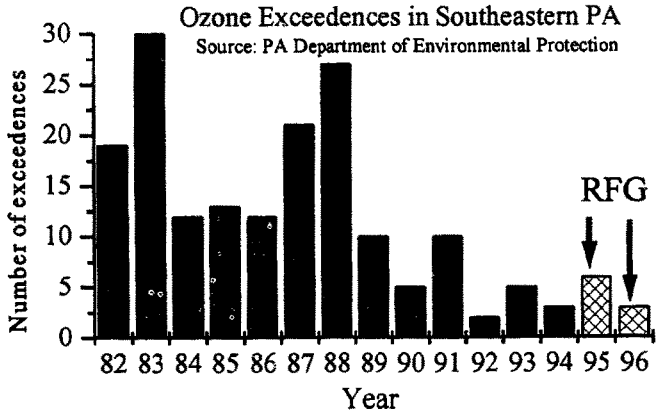


Figure 6



ADDENDUM TO PAPER 97-TA34.02 BY PETER M. JOSEPH, JUNE 8, 1997

After completing the manuscript for this paper in March, I learned of work performed by T. E. Kleindienst and EPA scientists in Research Triangle Park, NC. Their paper, No. 97-RP139.04, found no detectable levels of TBF in engine exhaust greater than 50 ppt. The paper does not say if a catalytic convertor was present in the experimental system. If subsequent studies confirm the absence of TBF in exhaust from MTBE fuels, it obviously rules out the hypothesis that TBF is the unknown MDT discussed in my paper.

However, it is known that TBF will rapidly pyrolyze into formic acid (FA) and isobutylene (ISB) (Gordon et al., J. Chem . Soc. 1957, 281315). The process is highly temperature dependent, and the rate constant increases rapidly with increasing temperature. At 500°K, the lifetime is about 10,000 seconds, while at 681G6°K it

is about 1 second. Since temperatures in the combustion chamber are obviously much higher, it is predicted that any TBF formed by partial oxidation of MTBE would rapidly decompose into FA and ISB. Furthermore, the work of Kleindienst et al does show a very large increase in ISB production comparing reference gasoline to RFG with MTBE. This increase is also temperature dependent, becoming larger at lower ambient temperatures. For example, the increase is 143 percent at 75°F, and rises to 555 percent at −20°F. Thus, this increase is consistent with the production of TBF by partial oxidation in the combustion process. The obvious implication is that FA is being produced in similar quantities. FA was explicitly mentioned in my paper as a possible candidate for the MDT.

In my oral presentation, I showed data obtained in 1960 by Amdur on the effect of FA on the airway resistance in unsensitized guinea pigs (Amdur, Int. J. Air Pollution, 1960;3:201–220). Amdur's data show a very significant increase in airway resistance from an acute exposure of the animals to 340 ppb of FA. By comparison, in another experiment conducted using exactly the same experimental setup, Amdur found no increase in airway resistance in the guinea pigs from exposure to 800 ppb of ozone. (Amdur, Am. Indust. Hygiene Ass. J. 1978: 39:958–961) Of course, it is true that ozone has deleterious effects at lower concentrations than 800 ppb, mainly in sensitized animals or in combination with other pollutants. However, since relatively little information on the respiratory effects of FA is available, this comparison of effects on airway resistance is the most straightforward comparison of FA and ozone available at this time. It obviously implies that FA is at least as toxic for the respiratory system as ozone.

There have been several measurements of FA in ambient air in recent years, but I could find none done in cities with MTBE-RFG. FA was measured in Philadelphia in the summer of 1992; the peak value found was 23 ppb.(Lawrence and Koutrakis, J. Geophys. Res. 1996;1O1:9171–9183) The highest concentrations reported to date were in the western Sierra Nevada mountains in California, where 40 ppb of FA was found in 1990. (Harrington et al, Atmos. Envir. 1993;27A:1843–1849) Obviously, new measurements of FA in urban areas using MTBE-RFG are desperately needed.

May 5, 1997.

DR. PETER JOSEPH
Hospital of University of Pennsylvania Department of Radiology
3400 Spruce Street
Philadelphia, PA 19104

SB 521 (MOUNTJOY)

As an unwilling victim of the chemical additive MTBE that now comprises 15 percent by volume of our reformulated gasolines, I had the opportunity to testify on April 15th at the Transportation Committee's hearing on this measure. The onset of my asthma about 10 years ago, started out as allergic reactions, then evolved to asthma. This coincides with the introduction of MTBE, initially in small quantities, and during only part of the year. Starting in March 1996, my asthma condition worsened, at the time MTBE was increased to 15 percent. My lung capacity was reduced by 80 percent, such that I was enrolled in a pulmonary rehabilitation program in a local hospital, at a cost of $3250. The reason I feel so positive about this is this: when I am out of state, where MTBE is not used, I feel immediate relief! Since March 1996, I have been up to the Seattle area three times to visit my son and his family. I was able to walk a mile there early last month, whereas here, I am in distress if I have to walk a few blocks!

I appeal to your sense of fairness and decency to support this bill and remove this known carcinogen from our gasolines until California can assure its citizens that this gasoline additive is safe and not harmful, to the air we breathe, or the water we drink. As you may know, some wells have already been shut down because of MTBE contamination (Santa Monica area).

I thought you might want to hear a personal account as you deliberate this most important measure.

Sincerely,

KATHY SIMPSON
897 Dolphin Ct.
Danville, CA 94526.

May 15, 1997.

I've lived in Pleasanton, CA since March of 94. Prior to that I lived in Castro Valley, CA. Several years ago, I noticed when Autumn arrived, I started having frequent headaches and a tremendous problem with tinitis. Stomach cramps and diarrhea would accompany these symptoms along with a general loss of energy. Where I once upon a time would go to bed with a headache and wake up feeling good, I was now going to bed feeling tired and waking up with a headache. These headaches always seemed to reside around my sinuses and would sometimes become migraine-like.

Last year, the symptoms grew tremendously worse. I thought I was losing my mind as the sickness got worse and I was having trouble remembering things. My older daughter suffered as I did, when I did. It was remarkable how I would come home from work and find here suffering exactly as I was. I do not believe in ESP, so this was really baffling to me. I've worked in management for years and was really beginning to feel inept. My reviews were showing it also. In my field, I am sought after and well respected. Finally, my job performance and general outlook on life suffered to the degree that a move from job and geographically seemed the only answer.

I landed a job in the Sierras near the Nevada border. No cars to speak of in the Church Camp where I am now employed. I took a 70 percent cut in pay. But here is the payoff. I feel so much better.

We are still in the process of moving up here from Pleasanton (Pleasant-not). On the weekends, we go down for business and to move more of our belongings up here. We drove down to Pleasanton last Sunday morning. By Sunday Noon, my ears were ringing like crazy. I awoke Monday morning with the worst of headaches which finally subsided around 2 PM after the strong ocean winds had been blowing a while. The cramps and diarrhea came right along with it. We drove back up to the mountains Monday evening and by Tuesday AM, we all felt better again. I have to go back on Saturday for a concert my daughters are in. We are all dreading it as all of us notice the MTBE more and more (plus I tend to get really irritable). Up until a couple of months ago, my wife and youngest daughter did not seem to be so adversely affected. They are suffering more an more as time goes on.

I cannot believe this stuff was ever allowed to begin with. I understand there are other states considering using this garbage. Have the oil companies no scruples? In Iowa, they use ethanol. I never have a problem when I'm back there. Politicians and oil money. What else can it be?

Thank you again for your perserverance.

DEXTER KOONTZ
Cold Springs, CA

A charter member of Oxy-busters. Our whole family helped organize Jody Water's first meeting.

30 BROOKLYN AVE.,
San Jose, CA, 95128, May 2, 1997.

To Whom It May Concern: My name is James Biebesheimer and I am 34 years old. For the most part of my life I have been a very active and somewhat athletic person with little or no serious health conditions. I am writing to explain to the world how MTBE in gasoline is really ruining my health and the quality of my life.

In July 1991 I moved from San Jose, California to Penrose, Colorado. At this time I was unemployed so I began working with the local farmers in a county where MTBE was not in use at that time. In the winter of 1992 I had found employment in Colorado Springs, and this is where I recall my problems first began. They were using gasoline oxygenated with MTBE at that time there. I would get rashes, breathing problems, headaches, and other conditions. But when I would return to Penrose where I lived my symptoms would seem to lessen. It seemed to me that when I would pump gas in Colorado Springs these effects would worsen, but when I would pump gas in Penrose where MTBE was not used I would have no problems. After the winter of 1992 I felt I could no longer work in Colorado Springs. I had decided that my illness was job related, so I decided to try another line of work (roofing). However, since most of the work was in the Colorado Springs area I again found myself feeling ill. As soon as I would return to Canon City I would feel better. Because of this I became a free lance landscaper in Canon City and I finished my stay in Colorado with no more complications. Looking back on this now it seems obvious that my problems occurred in those areas where MTBE was required to be in gasoline and they disappeared when I was in cities where it was not required. However, at the time I had no suspicion that MTBE in gasoline had anything to do with my health problems.

In June of 1995 I returned to California where, after six months of no problems, I again started to feel ill like I had a lingering cold. This corresponds pretty well

to the introduction of MTBE-RFG in November 1995. This was when I would get rashes, lightheadedness, difficulty breathing, chest pains, and headaches. I still had no idea that MTBE was causing my illness so I assumed it had something to do with my new place of employment, which was an electronics company.

In April of 1997 I went to see my physician Dr. Talbert. She told me to quit smoking which I did. However, my condition just seemed to get worse every day. Furthermore, I couldn't understand why my condition would get worse in the evening. I was given inhalers to counteract the breathing difficulties. These did work for a short period of time but I still suffered from dizziness and my other symptoms. In the evenings I would drive to work in rush hour traffic and by the time I got to work I would be in pretty bad shape.

At this point I took a suggestion from a person who has asthma. He suggested driving with the air recirculation on in my car. This did seem to help some. However, as soon as I would get out of the car and go into work, the problems would return. So at this time I started to experiment and tried driving with the windows down. This made me feel almost like I was drunk or high on something. So now I knew that what was bothering me was something in the air that I was breathing as I drove to work.

The next thing I tried was to go for a walk during high traffic hours. I can say that almost killed me! My eyes would water, and I couldn't breath, I got dizzy, lightheaded, tired, etc. Then I walked the same route late at night when traffic was very light. The symptoms from this were definitely reduced, but still present. At this point I was beginning to suspect some problem from gasoline so I asked my wife to pump our gas for one week. This somewhat reduced the symptoms, but nevertheless when I needed to drive my complications continued.

Finally in April 1997 I came across some information from Dr. Joseph about MTBE. On first reading his writings I thought his theory was impossible. However, I did talk to him and tried one of his suggestions. He said to go to the countryside to get away from the gas exhaust fumes. So I stayed at San Luis Reservoir for a whole weekend. That area has a forbay near the ocean so the air is very clean. During this stay I did not need my inhalers even once! However, after returning to San Jose, by Tuesday I was at the Emergency Room in Kaiser Permanente for breathing complications and chest pains.

Dr. Joseph told me that people's symptoms often get worse on cloudy and muggy days. I can say that is definitely the case for me. I guess it means that the air pollution gets worse on those days.

So, it is my conclusion that MTBE is either killing me or destroying my ability to live a normal and healthy life! If anyone wants more details about my problem, feel free to call me at 510353–7650 after 3:30 PM California time.

I freely give permission for this letter to be made public, including published, photocopied, or transcribed for transmission on the Internet. My hope is that my case will help to convince the government to ban the MTBE that is causing me and others so much misery and illness.

Sincerely,

JAMES E. BIEBESHEIMER

May 29, 1997.

DR. PETER JOSEPH
University of Pennsylvania Medical School
Philadelphia, PA

DEAR DR. JOSEPH: My story is far less dramatic than others that I have read regarding health effects that have occurred following the introduction of reformulated gas. However, they were severe enough to prompt me to move out of the congested area in which I lived in Los Angeles.

Very simply, although I had suffered from allergies and from chest infections over my entire fife, I had never suffered from sinus infections, nor from constant running in my right eye unfit the winter of 1993–1994. At that time, I began having to take antibiotics to overcome sinus infections. I noticed during that winter, when I traveled to see any sister on Mercer Island outside Seattle, that I had a considerably easier time breathing.

In the fall of 1994, I went to Hawaii. Within two days the chronic running in my eye had ceased and I could also breathe without constantly talking antihistimines. When I returned to Los Angeles, I became very ill with sinus infection right before Christmas and was on diffeecnt antibiotics off and on for four months. It was at that time, that I decided it was the "air" in Los Angeles, and that I had to move.

It took me several years of looking around California before I decided to move to Marin County. While this may not be my final move (although the housing is less expensive than Los Angeles, everything else is drastically more!), my eye no longer runs and I have not had a sinus infection since before Christmas, the first time I have gone through January, February, March, andApril off antibiotics in four years.

Where I lived in Los Angeles was in a condonunium building on a four lane boulevard, which had become heavily trafficked at rush hour in the past four or five years, as a short cut to the "regular" route into Beverly Ells and the Culver City Studios. Even today, when I go into Berkeley or Oakland, I notice that my eye starts to run if I am on a heavily trafficked street and that I begin to have "stuffiness" in my nose—these symptoms occur within a half hour of being around heavy traffic.

While this is anecdotal, it is so pronounced a difference that I am extremely careful to stay out of heavily trafficked situations if at all possible because the quality of my life is greatly improved without my being in densely travelled situations.

I am hoping that the Coalition for Clean Air will follow up on its pressure to have an investigation into the Health Effects of Reformulated Gas. The attitudes are so in favor of the "greatly cleaned air" as a result of said gas, that it is an uphill fight.

With best wishes and many thanks for your hard work,

Juliette Anthony.

ROBERT W. GROSS, PH.D.,
SANTA CLARA VALLEY WATER DISTRICT,
5750 Almaden Expressway, San Jose, CA 95118, December 4, 1997.

Senate Environment and Public Works Committee
Senate Hart Office Building
Washington, DC 20510

PERSONAL OPINION AND STATEMENT
METHYL TERTIARY BUTYL ETHER (MTBE)

HONORABLE CHAIR AND COMMITTEE MEMBERS: California should not compromise its water quality in the name of air quality by using a gasoline additive known as MTBE. It is my personal opinion, that MTBE should be prohibited immediately; and, should be unacceptable in California regardless of the levels of exposure to the drinking water supplies, the environment or humans.

The Santa Clara Valley Water District provides flood control and wholesale water supply for the 1.7 million residents of Santa Clara County. The District responsibilities include managing of the groundwater management program, we provide regulatory oversight for leaking underground storage tank (UST) investigation and cleanup. Over the last year and half, we have requested testing for methyl butyl ether (MINE) at UST sites where groundwater has been contaminated. MTBE has been detected at nearly 300 sites in the county, at concentrations as high as 430,000 μg/L. MTBE has not yet been detected in a water supply well as of this date. However, to protect the quality of our water supply, we have implemented an aggressive action plan. The impact of MTBE on the District include the use of significant staff resources, expenditure for public outreach and testing, and a loss of customer confidence in the water supply.

Santa Clara Valley Water District (SCVWD) manages 10 local reservoirs and the county's groundwater subbasins. It imports water; engages in programs aimed at protecting the quality of its' water sources; designs and builds water conveyance facilities; and operates three water treatment plants. The District sells both treated water and groundwater to 13 water retail agencies which service communities within the county with their own distribution systems.

Santa Clara County is better known throughout the world as Silicon Valley—headquarters to 4,895 high-tech companies and many thousand more industries and businesses. The valley is, in fact, a global economic engine, and this economy is currently generating about 850,000 jobs. It leads the entire San Francisco Bay Area in population size, building activity, retail sales and effective buying income.

At the same time, farming continues in the southern portion of Santa Clara County; in 1995, total crop value was estimated at $160 million. A greenbelt policy has preserved much of the valley's surrounding hillsides, and though greatly diminished by decades of urban growth, the riparian habitat and wetlands along the county's 700 miles of creeks and rivers remain and essential habitat for birds, fish and wildlife.

It is within this vibrant context that the SCVWD provides services essential to the area's well-being: water supply and flood protection. Serving as a water resource management agency, the District encompasses all of the county's 1,300 square miles and counts the area's 1.7 million residents as its' customers.

SCVWD is known nationally for its' groundwater clean up programs, public education, and the continual research which is required for the health and safety of its' water. It is the responsibility of the District to take every precaution needed in the protection of this valuable resource. Santa Clara County has been exposed to too many pollutants and to be exposed to one which has a questionable safety science is unacceptable in my opinion.

It is not my position to challenge the volumes of research which have been compiled on MTBE. However, it seems inconceivable that certain members of the legislative branch in Sacramento, health departments, and water district officials are failing to note the serious problem this chemical posses to the State's waters and environment. State and Federal officials have given safe health risk levels for MTBE in parts per billion (ppb) and are set very low—35 ppb and 70 ppb, respectively. However, if the average person can detect concentration levels between 15 to 40 ppb, this should tell the reader something is wrong. Let those scientist which publish and state to the public that low dosages of MTBE is not harmful to humans—ask a simple question, "why should the citizens of California be exposed to any pollutant, regardless of the level?"

California is struggling with environmental restrictions in the Delta. Every drop of water becomes more critical in the survival to the State's economy. Water cannot and should not be compromised with other resources; for nature has a delicate balance and individually—they must be protected with jealousy. If, we as elected leaders act contrary to this principal, it is criminal in my opinion.

Water districts today are being challenged over the issue of water quality (which includes taste, color and odor). To introduce another element into drinking waters may cause lack of public confidence in our treated water supplies. National water drinking regulations require escalating costs to treat the existing sources; if, an additional toxin is to be removed from our waters, "are those which support MTBE, willing to underwrite the expense in removing this chemical from the State's waters, or will it be a burden of the rate payer?"

Your support of California Senator Mountjoy's position is needed. It is the personal opinion of myself, MTBE should be removed from all gasoline products immediately in California until an independent group of scientific researchers establish there are no health risks related to this chemical.

Remember, "water is life, life is water, don't gamble with it!"

PETER GROSS PH.D.

MTBE OCCURRENCE DATA

MTBE AT LEAKING UST SITES

Highest Groundwater Concentration (ppb)	No. of Cases
>1- 35	44 (16%)
35 - 350	71 (25%)
350 - 3,500	101 (36%)
3,500 - 430,000	63 (23%)

279 Cases with Detection of MTBE

Santa Clara Valley Water District

October 21, 1997

MTBE OCCURRENCE DATA

LEAKING UST CASES

Total Groundwater Cases: 622
 # Gasoline: 500+
 # Monitoring for MTBE: 354
 # With Detection of MTBE: 279
➳79% of cases monitoring for MTBE detect it.

Santa Clara Valley Water District

October 21, 1997

Leaking UST Program

- ~2000 UST sites identified
- ~1000 groundwater (GW) cases
- ~400 GW sites have tested for MTBE
- ~300 GW sites have detected MTBE (75%)
- Concentrations as high as 430,000 ug/L

Groundwater Concerns

- MTBE behaves differently than other gasoline constituents (BTEX)
- Lack of guidance on investigation and cleanup
- Occurrence of MTBE at sites that meet 1998 upgrade requirements
- Abandoned wells and other conduits
- Public confidence

Santa Clara Valley Water District

MTBE Analysis

All results reported and analyzed by EPA Method 502.2 are not supported through a confirmation phase and should be interpreted as a presumptive result, but with high probability. All results reported and analyzed by EPA Method 524.2 are confirmed.

Sample Location	Collection depth	Collection Date	EPA Method	Results (ug/L)
Almaden	Surface	11/17/96	502.2	ND
Anderson	Surface	11/17/96	502.2	6.06
Calero	Surface	11/17/96	502.2	ND
Coyote	Surface	11/17/96	502.2	6.20
San Luis	Surface	11/17/96	502.2	ND
Rinconada Raw (SL71,DV19,And10)	Surface	11/17/96		
Rinconada Treated	Surface	11/17/96	502.2	ND
Penitencia Raw	Surface	11/17/96	502.2	ND
Penitencia Treated	Surface	11/17/96	502.2	ND
Santa Teresa Raw (SL88,And12)	Surface	11/17/96	502.2	
Santa Teresa Treated	Surface	11/17/96	502.2	ND
Anderson	Surface	3/19/97	502.2	ND
	3 meters	3/19/97	502.2	ND
	6 meters	3/19/97	502.2	ND
Calero	Surface	3/19/97	502.2	ND
	3 meters	3/19/97	502.2	9.27
	6 meters	3/19/97	502.2	ND
Coyote	Surface	3/19/97	502.2	ND
	3 meters	3/19/97	502.2	ND
	6meters	3/19/97	502.2	ND
Anderson	Surface	4/16/97	502.2	ND
	3 meters	4/16/97	502.2	ND
	6 meters	4/16/97	502.2	ND
Calero	Surface	4/22/97	502.2	ND
	3 meters	4/22/97	502.2	ND
	6 meters	4/22/97	502.2	ND
Coyote	Surface	4/15/97	502.2	ND
	3 meters	4/15/97	502.2	ND
	6 meters	4/15/97	502.2	ND
South Bay Delta (SBA)	Penitencia Influent	4/22/97	502.2	ND
Rinconada Treated	WTP	4/22/97	502.2	ND
Penitencia Treated	WTP	4/22/97	502.2	ND

Sample Location	Collection depth	Collection Date	EPA Method	Results (ug/L)
Santa Teresa Treated	WTP	4/22/97	502.2	ND
Anderson	Surface	5/13/97	524.2	6.1
	3 meters	5/13/97	524.2	5.2
	6 meters	5/13/97	524.2	5.2
Calero	Surface	5/13/97	524.2	9.4
	3 meters	5/13/97	524.2	10.0
	6 meters	5/13/97	524.2	8.0
Coyote	Surface	5/14/97	524.2	7.2
	3 meters	5/14/97	524.2	6.4
	6 meters	5/14/97	524.2	6.3
South Bay Delta (SBA)	Penitencia Influent	5/14/97	524.2	ND
Rinconada Treated	WTP	5/14/97	524.2	ND
Penitencia Treated	WTP	5/14/97	524.2	ND
Santa Teresa Treated	WTP	5/14/97	524.2	ND
Anderson	Surface	6/16/97	502.2	5.3
	3 Meters	6/16/97	502.2	ND
	6 Meters	6/16/97	502.2	ND
Calero	Surface	6/16/97	502.2	7.0
	3 Meters	6/16/97	502.2	6.2
	6 Meters	6/16/97	502.2	6.3
Coyote	Surface	6/12/97	502.2	5.4
	3 Meters	6/12/97	502.2	ND
	6 Meters	6/12/97	502.2	ND
South Bay Delta (SBA)	Penitencia Influent	6/10/97	502.2	ND
Rinconada Treated	WTP	6/10/97	524.2	ND
Penitencia Treated	WTP	6/10/97	524.2	ND
Santa Teresa Treated	WTP	6/10/97	524.2	ND
Anderson	Surface	7/7/97	502.2	ND
	3 Meters	7/7/97	502.2	ND
	6 Meters	7/7/97	502.2	ND
Thermocline @ 12-15M	13 Meters	7/7/97	502.2	ND
	18 Meters	7/7/97	502.2	ND
Calero	Surface	7/14/97	502.2	8.6
	3 Meters	7/14/97	502.2	7.8
	6 Meters	7/14/97	502.2	7.9
Thermocline @ 9-12M	15 Meters	7/14/97	502.2	ND
	18 Meters	7/14/97	502.2	ND
Coyote	Surface	7/15/97	502.2	6.0
	3 Meters	7/15/97	502.2	6.0

Sample Location	Collection depth	Collection Date	EPA Method	Results (ug/L)
Uniform Temp.	6 Meters	7/15/97	502.2	6.0
	8 Meters	7/15/97	502.2	5.4
South Bay Delta (SBA)	Penitencia Influent	7/24/97	524.2	ND
Rinconada Treated	WTP	7/23/97	524.2	ND
Penitencia Treated	WTP	7/23/97	524.2	ND
Santa Teresa Treated	WTP	7/23/97	524.2	ND
Anderson	Vault (Middle Port)	7/31/97	524.2	ND
Santa Teresa Influent 55% SL & 45% Anderson	WTP	7/31/97	524.2	ND
Santa Teresa Treated	WTP	7/31/97	524.2	ND
Rinconada Treated	WTP	7/31/97	524.2	ND
Penitencia Treated	WTP	7/31/97	524.2	ND
Anderson	Vault (Middle Port)	8/7/97	524.2	ND
Santa Teresa Influent 50% SL & 50% Anderson	WTP	8/7/97	524.2	ND
Santa Teresa Treated	WTP	8/7/97	524.2	ND
Rinconada Treated	WTP	8/7/97	524.2	ND
Penitencia Treated	WTP	8/7/97	524.2	ND
Anderson	Vault (Middle Port)	8/14/97	524.2	ND
Santa Teresa Influent 54% SL & 46% Anderson	WTP	8/14/97	524.2	ND
Penitencia Influent	WTP	8/14/97	524.2	ND
Santa Teresa Treated	WTP	8/14/97	524.2	ND
Rinconada Treated	WTP	8/14/97	524.2	ND
Penitencia Treated	WTP	8/14/97	524.2	ND
Anderson	Surface	8/11/97	502.2	ND
	3 Meters	8/11/97	502.2	ND
	21 Meters	8/11/97	502.2	ND
Calero	Surface	8/11/97	502.2	ND
	3 Meters	8/11/97	502.2	ND
	6 Meters	8/11/97	502.2	ND
Coyote	Surface	8/12/97	502.2	ND
	3 Meters	8/12/97	502.2	ND
	6 Meters	8/12/97	502.2	ND
	15 Meters	8/12/97	502.2	ND
Anderson	Vault (Middle Port)	8/21/97	524.2	ND
Santa Teresa Influent 71% SL & 29% Anderson	WTP	8/21/97	524.2	ND
Penitencia Influent	WTP	8/21/97	524.2	ND
Santa Teresa Treated	WTP	8/21/97	524.2	ND
Rinconada Treated	WTP	8/21/97	524.2	ND
Penitencia Treated	WTP	8/21/97	524.2	ND

Sample Location	Collection depth	Collection Date	EPA Method	Results (ug/L)
Anderson	Vault (Middle Port)	8/28/97	524.2	ND
Santa Teresa Influent 66SL & 34Anderson	WTP	8/28/97	524.2	ND
Penitencia Influent 100%SBA	WTP	8/28/97	524.2	ND
Santa Teresa Treated	WTP	8/28/97	524.2	ND
Rinconada Treated	WTP	8/28/97	524.2	ND
Penitencia Treated	WTP	8/28/97	524.2	7.0*
Anderson	Vault (Middle Port)	9/4/97	524.2	ND
Santa Teresa Influent 88% SL & 12%Anderson	WTP	9/4/97	524.2	ND
Penitencia Influent 77%SBA &23%DV	WTP	9/4/97	524.2	ND
Santa Teresa Treated	WTP	9/4/97	524.2	ND
Rinconada Treated	WTP	9/4/97	524.2	ND
Penitencia Treated	WTP	9/4/97	524.2	ND
Anderson	Vault (Middle Port)	9/11/97	524.2	ND
Santa Teresa Influent 100% SL	WTP	9/11/97	524.2	ND
Penitencia Influent 45%SBA & 55%DV	WTP	9/11/97	524.2	ND
Santa Teresa Treated	WTP	9/11/97	524.2	ND
Rinconada Treated	WTP	9/11/97	524.2	ND
Penitencia Treated	WTP	9/11/97	524.2	ND
Anderson	Surface	9/15/97	502.2	ND
	3 Meters	9/15/97	502.2	5.3
	6 Meters	9/15/97	502.2	ND
	20 Meters	9/15/97	502.2	ND
Calero	Surface	9/22/97	502.2	ND
	3 Meters	9/22/97	502.2	ND
	6 Meters	9/22/97	502.2	ND
Coyote	Surface	9/16/97	502.2	ND
	3 Meters	9/16/97	502.2	8.6
	6 Meters	9/16/97	502.2	5.5
Anderson	Vault (Middle Port)	9/18/97	524.2	ND
Santa Teresa Influent 100% Anderson	WTP	9/18/97	524.2	ND
Penitencia Influent 45%SBA & 55%DV	WTP	9/18/97	524.2	ND
Santa Teresa Treated	WTP	9/18/97	524.2	ND
Rinconada Treated	WTP	9/18/97	524.2	ND
Penitencia Treated	WTP	9/18/97	524.2	ND

Sample Location	Collection depth	Collection Date	EPA Method	Results (ug/L)
Anderson	Vault (Middle Port)	9/25/97	524.2	ND
Santa Teresa Influent 100% Anderson	WTP	9/25/97	524.2	ND
Penitencia Influent 45%SBA & 55%DV	WTP	9/25/97	524.2	ND
Santa Teresa Treated	WTP	9/25/97	524.2	ND
Rinconada Treated	WTP	9/25/97	524.2	ND
Penitencia Treated	WTP	9/25/97	524.2	ND
Anderson	Vault (Upper Port)	10/2/97	524.2	ND
Santa Teresa Influent 100% Anderson	WTP	10/2/97	524.2	ND
Penitencia Influent 32%SBA & 68%DV	WTP	10/2/97	524.2	ND
Santa Teresa Treated	WTP	10/2/97	524.2	ND
Rinconada Treated	WTP	10/2/97	524.2	ND
Penitencia Treated	WTP	10/2/97	524.2	ND
Anderson	Vault (Upper Port)	10/9/97	524.2	ND
Santa Teresa Influent 100% Anderson	WTP	10/9/97	524.2	ND
Penitencia Influent 29%SBA & 71%DV	WTP	10/9/97	524.2	ND
Santa Teresa Treated	WTP	10/9/97	524.2	ND
Rinconada Treated	WTP	10/9/97	524.2	ND
Penitencia Treated	WTP	10/9/97	524.2	ND
Anderson	Vault (Upper Port)	10/16/97	524.2	ND
Santa Teresa Influent 100% Anderson	WTP	10/16/97	524.2	ND
Penitencia Influent 50%SBA & 50%DV	WTP	10/16/97	524.2	ND
Santa Teresa Treated	WTP	10/16/97	524.2	ND
Rinconada Treated	WTP	10/16/97	524.2	ND
Penitencia Treated	WTP	10/16/97	524.2	ND
Anderson	Vault (Upper Port)	10/23/97	524.2	6.7
Santa Teresa Influent 100% Anderson	WTP	10/23/97	524.2	ND
Penitencia Influent 50%SBA & 50%DV	WTP	10/23/97	524.2	ND
Santa Teresa Treated	WTP	10/23/97	524.2	ND
Rinconada Treated	WTP	10/23/97	524.2	ND
Penitencia Treated	WTP	10/23/97	524.2	ND
Anderson	Surface	10/20/97	502.2	8.3
	3 Meters	10/20/97	502.2	20.2
	6 Meters	10/20/97	502.2	ND
	18 Meters	10/20/97	502.2	13.0

Sample Location	Collection depth	Collection Date	EPA Method	Results (ug/L)
Calero	Surface	10/27/97	502.2	ND
	3 Meters	10/27/97	502.2	ND
	6 Meters	10/27/97	502.2	ND
Coyote	Surface	10/28/97	502.2	ND
	3 Meters			Bottom
	6 Meters			Bottom
Anderson	Vault (Upper Port)	10/29/97	524.2	ND
Santa Teresa Influent 100% Anderson	WTP	10/29/97	524.2	ND
Penitencia Influent 50%SBA & 50%DV	WTP	10/29/97	524.2	ND
Santa Teresa Treated	WTP	10/29/97	524.2	ND
Rinconada Treated	WTP	10/29/97	524.2	ND
Penitencia Treated	WTP	10/29/97	524.2	ND
Anderson	Surface	11/10/97	502.2	ND
	3 Meters	11/10/97	502.2	ND
	6 Meters	11/10/97	502.2	ND
	18 Meters	11/10/97	502.2	ND
Anderson	Vault (Upper Port)	11/13/97	524.2	ND
Santa Teresa Influent 100% Anderson	WTP	11/13/97	524.2	ND
Penitencia Influent 100%SBA	WTP	11/13/97	524.2	ND
Santa Teresa Treated	WTP	11/13/97	524.2	ND
Rinconada Treated	WTP	11/13/97	524.2	ND
Penitencia Treated	WTP	11/13/97	524.2	ND

THE UC DAVIS TAHOE RESEARCH GROUP

SOURCES, TRANSPORT AND PERSISTENCE OF MTBE IN A SIERRA NEVADA MULTIPLE USE LAKE

Results

Discovery of the gasoline additive methyl tert-butyl ether (MTBE) in groundwater, and lakes and reservoirs used for drinking water has raised considerable concern among public health officials and water suppliers in California. The U. S. Environmental Protection Agency has classified MTBE as a possible human carcinogen and has a draft health advisory for drinking water of 20 to 200 μg/L or parts per billion (ppb). California state action levels have been established at 35 ppb. Possible sources of MTBE in shallow groundwater include direct contamination from leaking storage tanks and indirect contamination from stormwater flow and precipitation which washes through the urban atmosphere. Because of MTBE's possible health affects and the fact that it is highly soluble in water and difficult to biodegrade, its potential persistence in surface water supplies has recently raised public and legislative concerns as well as numerous questions which require additional research. Studies on fate and transport in drinking water lakes are negligible.

Since March 26, 1997 lake water quality scientists from the Tahoe Research Group (TRG) at the University of California, Davis have been studying sources, transport and fate of MTBE in Donner Lake. Donner Lake is located at the summit of Interstate 80 as it passes through the Sierra Nevada in California and is 12 miles northwest of the renown Lake Tahoe. Donner Lake lies at an elevation of 5,936 feet above sea level with a surface area of 1.5 square miles. It's volume is approximately 102,000 acre-feet with a maximum depth of 230 feet and an average depth of 109 feet. Among its designated beneficial uses Donner Lake is a source of drinking water, contact and non-contact water recreation, sportfishing, freshwater and spawning habitat for coldwater fish, and downstream its water support habitat nec-

essary for the survival and maintenance of fish species listed under law as threatened and/or endangered.

The UCD-TRG scientific team of John E. Reuter, Brant Allen, Bob Richards and Charles R. Goldman, and Scott Seyfried a senior scientist with the firm of Levine-Fricke-Recon (Roseville, CAL, sampled the lake on 13 dates between March and October 1997. In total, nearly 500 individual lake water samples have been analyzed for MTBE. In cooperation with Dr. Roger Scholl, Laboratory Director for Alpha Analytical, Inc. a commercial water quality laboratory in Sparks, NV, high sensitivity detection limits of 0.1 ppb were achieved specifically for this research effort. This represents one of the most extensive field studies of MTBE in lakes in the nation. The sampling effort was designed in a systematic manner in order to answer a number of important questions including: the relative contribution of recreational water craft as a source of MTBE, the extent of MTBE transport from surface waters into deeper portions of the lake, the loss rate of MTBE from the water column, persistence of MTBE during the fall and winter, and influence of meteorological factors such as air and water temperature and wind velocity on MTBE.

Results

- MTBE concentrations in the 490 samples ranged from 0.09 to 12.1 ppb.
- Concentrations of MTBE were regularly distributed throughout the entire surface area of the lake.
- Residual concentrations carried over from 1996 to 1997 were in the range of 0.15–0.30 ppb.
- Approximately 30 days after the Summit Creek fuel spill, MTBE in Donner Lake was only 0.3–0.4 ppb suggesting no significant impact.
- Beginning in early May, and coincident with the onset of the summer boating season, MTBE concentrations in the surface waters increased from a low value of 0.1 ppb on April 24 to approximately 2 ppb just prior to the Fourth of July weekend.
- Sampling on July 7 showed a dramatic 6-fold increase of MTBE in surface water from 2 to 12 ppb. This increase is most likely the result of increased fuel exhaust into Donner Lake from recreational watercraft since rainfall and urban runoff was negligible at this time, and since stream flow was nearing its seasonal minimum.
- Boat use data obtained from the Truckee Donner Park and Recreation ramp was highly correlated with the seasonal MTBE budget. A statistically significant and linear relationship was found between boat use and MTBE. Indeed. nearly 90 percent of the observed variation in whole-lake MTBE content could be explained by changes in seasonal and weekly boat use.
- MTBE in the upper and warmer portion of the lake (0–35 feet deep) was uniformly high as the result of natural wind mixing of these waters. Below approximately 50 feet in the colder uncirculated waters MTBE was always less than 0.5 ppb. This distinct distribution results from the formation of a stable density boundary (thermocline) in the lake which prevents mixing between the surface and bottom waters.
- During March and April, before boating activity increased on the lake, it was calculated that Donner Lake contained 45–65 pounds of MTBE. By July 1 this had increased to 250 pounds with a sharp increase to the maximum of 815 pounds shortly after the July 4 holiday. Over the September 1 Labor Day weekend MTBE also increased but much less dramatically (i.e. approximately a 100 pound increase).
- During the summer period July 7 to September 3, 269 pounds of MTBE was lost from the lake as a result of volatilization. However, in a dramatic fashion, in the 27 days between 3–30 September a disappearance of 492 pounds was measured.
- In that period only 37 pounds left the lake via water release through the outflow weir. The remaining 455 pounds appears to have been volatilized. This occurred prior to lake mixing.
- This translates into a loss rate of 16–17 pounds per day or a half-life of approximately 28 days. This is supported by theoretical calculations which calculates that under the conditions for wind, temperature, current velocity and depth (mean depth of 6 meters) found at Donner Lake, the expected MTBE half-life would be 15–25 days.

Conclusions

1. Recreational boating in Donner Lake is clearly the most important source of MTBE in that lake. Since there are no fueling pumps on the lake, it would appear that engine exhaust and not spills during fueling is the major factor. Neither urban runoff nor precipitation contributed significantly to MTBE in Donner Lake.

2. The major loss of MTBE appeared to be by volatilization at the air-water interface. During the summer when boating occurs the net loss rate of MTBE from

Donner Lake was 2–3 pounds per day. When boating is curtailed and new sources decline, the calculated volatilization rate increased significantly to 16–17 pounds per day.

3. Concentrations are expected to reach baseline before complete mixing.

4. Since MTBE did not move though the thermocline into deeper waters during the summer and since concentrations have declined before lake mixing, accumulation of MTBE in the bottom waters is not expected. Data collected prior to the 1997 boating season confirm this conclusion.

5. Research at Donner Lake has broad applicability and transferability to other lakes both within California and nationally. The importance of the type of research to policy decisions is significant. We hope to be able to combine our field research with our ongoing modeling efforts to more fully understand the impact of MTBE in freshwaters.

OXY-BUSTERS OF NEW JERSEY
SOUTHERN DIVISION
158 GREAT ROAD
Maple Shade, NJ 08052, December 7, 1997

U.S. Senate
Committee on Environment and Public Works
Senate Hart Office Building
Washington, DC 20510

Re: Hearing on MTBE sponsored by Senator Barbara Boxer, 12/9/97

On behalf of Oxy-Busters of NJ, a grassroots organization, I would like to comment on the issue of the use of gasoline oxygenates such as MTBE. Please include this letter as a formal part of the record for the above hearing.

Thousands of people in NJ began experiencing severe health reactions to high levels of MTBE in November of 1992, when the wintertime oxygenated fuel program started. Symptoms included chest pains, breathing difficulties, headaches, nose bleeds, eye pain and sinus problems. In addition, people felt tired and lethargic. For myself and many others, the connection between these symptoms and oxygenated gasoline was quite clear. While I was driving my car, filling it with gas, or just walking down a traffic filled street, my symptoms were severe. When I was in my house, the symptoms were less severe, but they persisted, as if caused by some pollutant in the air. Most of us noticed that the symptoms were worse on cloudy days. We felt sick all winter long, until conventional gas returned in the spring. When oxygenated fuel started again the next November, the symptoms were back.

Our group formed in 1993, in anticipation of another winter of oxygenated fuel. Over 15,000 people signed a petition to ban oxygenated fuel, which was presented to Governor Whitman in 1995. Over 1,000 NJ residents have called the Oxy-Buster hotline complaining about health problems they attribute to this new gasoline. For the most part, they all have the same symptoms described above.

People are still getting sick in NJ from reformulated gasoline (RFG) which is used all year long and contains at least 11 percent MTBE. In addition, MTBE has begun to contaminate our water, which the U.S.G.S. can attest to.

Although the EPA claims that MTBE has been widely tested, the combustible byproducts of MTBE mixed with gasoline have never been tested. What is clear is that asthma rates have been steadily increasing in this country since 1979, when MTBE was first introduced into gasoline. In recent years, asthma rates seem to be dramatically increasing almost in tandem with the increased use of MTBE.

The recent announcements by Tosco and Chevron, that oxygenates do little to reduce ozone, support what we have been saying for over two years. We based this contention on the Auto/Oil industry studies, a Chevron Technical Bulletin of November 1994, the National Research Council report on MTBE of June 1996, and our own study of ozone levels in Philadelphia from 1993 to 1996. All these sources indicated that oxygenates did little or nothing to reduce ozone. Our own report showed virtually no change in ozone levels relative to temperature after the introduction of RFG in Philadelphia in 1995.

Our-group is dedicated to the elimination of oxygenates from gasoline, and we will continue to protest their use until this goal has been accomplished.

ncerely,

BARRY DORFMAN,
Director of Special Projects.

December 31, 1997.

THE HONORABLE JOHN H. CHAFEE
United States Senate
Washington, DC. 20510
DEAR SENATOR CHAFEE: Attached are Kern Oil & Refining Co.'s comments to the recent issue of MTBE in gasoline being considered by the U.S. Senate Environmental and Public Works Committee and the subject of Senator Boxer's December 9, 1997 hearing in Sacramento. These comments were submitted to Senator Boxer's office via fax and regular mail on December 23, 1997. Thank you for the opportunity to present comments to your committee.

Respectfully,

THOMAS L. EVELAND, *Vice President,*
Governmental Affairs Kern Oil & Refining Co.

KERN OIL AND REFINING CO.
7724 EAST PANAMA LANE
Bakersfield, CA 93307-9210, December 23, 1997

THE HONORABLE BARBARA BOXER
United States Senate
Washington, DC 20510-0505

RE: MTBE Hearing in Sacramento

DEAR SENATOR BOXER: Kern Oil & Refining Co. (Kern) is pleased to submit comments for your consideration and that of the Senate Committee on the Environment and Public Works, regarding the environmental issues related to the use of methyl tertiary butyl ether (MTBE) in gasoline, which was the subject of your December 9, 1997, hearing in Sacramento.

Kern is a small independent petroleum refiner in Bakersfield, California. In fact, Kern is the only small refiner in California that has made the substantial investments and operational changes necessary to produce the cleaner burning gasoline now required in California. Kern has spent multiple millions of dollars upgrading its refinery to produce cleaner burning gasoline.

Kern's investments in refinery modifications to make cleaner burning gasoline were based on the use of MTBE as a blending component due to its projected availability and superior blending characteristics. Unlike Chevron, Tosco, and the other large refiners in California who have broad operating flexibility with multiple processing units, Kern has only one viable gasoline processing scenario. That scenario requires MTBE or other oxygenates in volumes sufficient to supply the needed octane quality and distillation characteristics and to minimize the benzene and aromatic hydrocarbon content of Kern's gasoline, in addition to providing the currently mandated oxygen content. In other words, Kern's gasoline production is quite complex, requiring MTBE or a substance with similar blending characteristics to meet state requirements whether or not Kern's gasoline were required to contain oxygen. Kern simply does not have the flexibility in its refinery nor the financial resources and capability necessary to make the technological investments to produce oxygen-free cleaner burning gasoline. And since Kern derives over one-third of its revenues from gasoline, it would be unable to survive if it were precluded from producing gasoline. This would seriously impact not only gasoline supplies in the southern San Joaquin Valley but also diesel fuel supplies in this strong agricultural region of the state.

Senator, it is important to note that Kern has made numerous inquiries to potential oxygenate suppliers to determine whether any oxygenate other than MTBE could be made available. Our exhaustive search (as well as that of others, we understand) has yielded no current supplies and no prospect of future supplies.

Ethanol is a separate issue from the other potential oxygenates. In addition to being in approximate supply-demand balance nationwide already with little or no available surplus to meet a huge potential California demand, it has serious environmental, water contamination, and economic problems as a gasoline blending component. Ethanol, unlike MTBE and other ethers, causes a one or two psi increase in the vapor pressure of the base gasoline with which it is blended. This in turn increases the evaporative emissions from the fuel, making it incompatible with summer season (April through October in our area) volatility limits. In addition, ethanol is very susceptible to water contamination. This is the reason common carrier pipelines prohibit ethanol-blended gasoline. While water contamination is a concern with regard to MTBE, Kern is concerned about the much greater potential for water contamination with ethanol-blended gasoline. Also, ethanol requires large government subsidies to be economically viable as a gasoline blending component. California does not provide ethanol-blending subsidies, making blending of ethanol

into gasoline uneconomical in California. Ethanol is not blended into gasoline in California and is not likely to be in the near future because of all the above negative factors associated with ethanol as a blending component. Conversion of ethanol to ETBE overcomes some but not all of ethanol's shortcomings as a gasoline blending component however, the major problems of availability and cost are not obviated by the conversion of ethanol to ETBE which has occurred only to a very limited extent nationwide.

We would like to point out that the health and environmental impacts of MTBE have been the subject of many extensive studies. MTBE is only an environmental problem if it leaks into ground water from storage tanks or pipelines. Legislation is already in place with regard to storage tank and pipeline leak prevention. Although there are detectable concentrations of MTBE in urban air, airborne MTBE is not a health threat because of the extremely low concentrations. MTBE also has been detected near the surface of lakes that have gasoline engine-powered watercraft, but here again, it has not been found in levels that could cause a threat to human health.

The obvious solution to the potential (and in at least two California communities, real) threat of MTBE ground water contamination is to prevent it from getting into the ground water. Indeed, no components of gasoline should be allowed to contaminate ground water. This will require replacement of all leaking tanks and pipelines, effective monitoring of all tanks and pipelines for future leaks, and remediation of contaminated soils that threaten drinking mater resources. Again, as previously stated legislation has been passed with regard to these issues.

Testimony at your December 9 hearing from the Santa Monica Director of Environment and Public Works Management would lead one to suspect that MTBE can pass through "new" properly designed underground tanks to contaminate ground water. That witness was not competent to make such a statement, and the statement of course was patently inaccurate. We have seven or eight years of experience in storing MTBE and MTBE-gasoline blends. Our tanks have extremely sensitive (part per billion level) leak detection devices, and we can competently testify that MTBE is no more corrosive to steel tanks than other gasoline components.

Senator Boxer, Kern sincerely appreciates your taking a personal interest in devising a means to protect the health and well-being of all Californians. We ask, however, that you and all government officials "look before you leap" and be sure that in attempting to solve one problem you don't create a larger one. The problem is not MTBE, but underground tanks and pipelines that leak MTBE, benzene, and other gasoline components into the soil and ground water. Only tough leak detection and tank integrity standards rigorously enforced will prevent drinking water contamination from MTBE and other components of gasoline. Again, MTBE as a gasoline component is not the problem...it is a safe and viable necessity.

Respectfully submitted,

THOMAS L. EVELAND
Vice President, Government Affairs

SIMPSON ASSOCIATES, M.B.A., C.P.A. REAL INSTATE CONSULTANTS
897 DOLPHIN COURT,
Danville, CA 94526, 12 December 1997

Senate Committee on Environment and Public Works
Washington, DC 20510

SENATOR BOXER: This year I have testified numerous times at the State Capitol in support of SB 521 (Mountjoy) regarding MTBE and its toxic effects on my health.

My airways have shut down by 80 percent since the Spring of 1996, when MTBE was increased to 11 percent by volume in gasolines. I was so disabled that my physician enrolled me in a pulmonary rehabilitation program where I learned I could die from an asthma attack during the night if my inhalers weren't on my night table. I had no asthma as a child or young adult. I now must use 4 inhalers numerous times during the day to keep my airways open. I cannot walk more than 2 blocks without becoming symptomatic and having to use an inhaler.

I offer this simple proof that MTBE is the culprit . . . I've just returned from 2 weeks in suburban Seattle, where there is no MTBE and, presto . . . I can breathe easily again and walk for a mile without wheezing or stopping to use an inhaler. Each time I leave California for an MTBE-free state (sic, Washington), I experience a dramatic reduction of asthmatic symptoms.

Methyl Tertiary Butyl Ether (MTBE) has polluted the air and now threatens our drinking water in various parts of the state. It must be banned!

Sincerely,

KATHY SIMPSON.

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